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DEPARTMENT OF THE INTERIOR,

BUREAU OF AGRICULTURE—BULLETIN No. 3.

F. LAMSON-SCRIBNER, Chief of Bureau.

SOIL CONDITIONS IN THE PHILIPPINES

BY

CLARENCE W. DORSEY, Soil Physicist,

In Charge of Soil Investigations.

MANILA:
BUREAU OF PUBLIC PRINTING.
1903.

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LETTER OF TRANSMITTAL.

BUREAU OF AGRICULTURE,

Manila, P. I., March 13, 1903.

SIR: I have the honor to transmit herewith, for publication as a bulletin of this Bureau, a paper on the soil conditions in the Philippines. This contains the results of my examinations and studies of the soils in the various parts of the archipelago that I have visited since my arrival in Manila, May 21, 1902. Many exaggerated statements are made about the inexhaustible fertility and wonderful resources of the soils of the Philippines, by persons doubtless misled by the luxurious tropical vegetation. While it is true that vast areas of fertile soils are found, that will respond abundantly to modern cultural methods, there are also many localities where agricultural advancement can only be made by considerable expenditure of time and money. In spite of the fact that agriculture has been carried on for many centuries in the islands, the methods employed are crude and primitive in the extreme, and cannot be expected to realize the true producing value of the soil.

That certain districts possess soils adapted to the cultivation of Manila hemp, sugar-cane, rice, tobacco, cocoanuts, coffee and cacao, has been proved beyond a doubt; but there are also many fine tracts of land where these industries can be greatly extended and improved, and new crops, such as cotton and tea, a host of fine fruits and minor produce crops can be profitably introduced. It is hoped that the descriptions of the soil and climatic conditions of the many localities visited may prove of benefit to those already engaged in agricultural pursuits, as well as those who may seek information concerning the natural resources and advantages of the islands, with the object of developing the latent energies of the soil.

Respectfully,

CLARENCE W. DORSEY, *Soil Physicist.*

Prof. F. LAMSON-SCRIBNER,
Chief of Bureau of Agriculture.

SOIL CONDITIONS IN THE PHILIPPINES.

INTRODUCTION.

At the time the Bureau of Agriculture was organized, early in 1902, it was recommended by the chief of the Bureau that soil investigations be carried on, similar to the work conducted by the Bureau of Soils of the United States Department of Agriculture. Arrangements were made for the temporary transfer of some one employed in the Bureau of Soils to inaugurate the work and to provide permanent plans for the further extension of soil work in the Philippines. The writer was selected for inaugurating the work and arrived in Manila the latter part of May, 1902. Many localities were visited and a glance at the accompanying sketch map will show where the soils have been examined in detail. Many months were spent in visiting the different parts of the Archipelago, but much time was lost, owing to the slow methods of available transportation, especially on account of the long periods of quarantine in going from one point to another in the districts then infected with cholera.

SOIL CONDITIONS IN THE ABACÁ OR MANILA HEMP DISTRICTS.

At the present time abacá, or Manila hemp,¹ ranks foremost among the exports of the Philippine Archipelago. While the excellent qualities of the fiber obtained from the abacá plant (a species of the banana family known as *Musa textilis*) have undoubtedly been known to the natives for hundreds of years, it is only during the last fifty or sixty years that considerable quantities of this material have been exported.

It is stated that in the year 1850, 7,309,296 kilos of abacá were exported. Twenty-five years later the shipment had increased to 32,414,315 kilos, while for the fiscal year 1901 111,216,563 kilos² were exported, which brought \$14,453,110.10, so that some idea can be gained of the wealth this industry brings to the Archipelago. Abacá fiber is used principally for making ropes and heavy cables and for binder twine, although large quantities of the finer qualities are consumed by the natives for weaving into various kinds of cloth.

¹ In this report the term abacá, used almost exclusively in the Archipelago to designate the plant known to botanists as *Musa textilis*, will be substituted instead of the terms hemp, Manila hemp or Manila.

² Monthly Summary of Commerce of the Philippine Islands, June, 1901.

The area of the Archipelago where the successful cultivation of abacá is carried on, roughly speaking, lies between the parallels 6° and 14° north latitude and the meridians 121° and 126° east of Greenwich. In southern Luzon the principal abacá producing provinces are Ambos Camarines, Albay, including the Island of Catanduanes, and Sorsogon. The Islands Mindoro, Marinduque, Masbate, Samar, Biliran, Leyte, Cebu, Panay, Negros, Bohol, and Mindanao produce greater or less quantities of abacá fibers. In addition, the plant is grown on a large number of smaller islands which lie near some of those just mentioned. In many of the islands mentioned only small quantities of abacá are gathered, and frequently the little gathered is of inferior quality.

For the successful cultivation of abacá certain favorable soil conditions are essential, as well as suitable climatic conditions. The soil must be of lasting fertility and must be well drained, for abacá will not grow well on wet, poorly drained soils. The soils should be light and loamy, cool and moist. Gentle slopes, with what are known as "cool" lands, are to be preferred to swampy, low lying lands, often locally known as "hot" lands.

A moist climate is required, and it is often remarked in the abacá districts that the rainy season lasts the entire year, for the plant will not survive a period of six months of dry weather, and is seriously injured if more than six weeks elapse without some rainfall. A moist atmosphere, with heavy showers at short intervals, seems best adapted to the needs of the plant, with the present system of cultivation.

With the object of a preliminary study of the soils of some of the more important abacá regions, considerable time was spent by the writer in the Provinces of Ambos Camarines, Albay, and Sorsogon in southern Luzon, as well as the more important regions of central western Samar and northeastern Leyte.

AMBOS CAMARINES.

In the Province of Ambos Camarines there are several important abacá regions, the products of which are nearly all shipped from Daet and the capital, Nueva Caceres, situated near the center of the province on the Bicol River. The Mount Iriga district was the only one studied in any detail, but as the exports of abacá amount to from 3,125,000 to 3,437,500 kilos per year, it can be seen that it is an important one. Other important districts are situated in the eastern part of the province in the vicinity of Lagonoy and in the western part of the province, especially in the country adjoining Pamplona. The Mount Iriga district is situated in the southeastern part of the province, and all of the abacá shipped from the villages of Iriga, Buhi and Baao may be said to come from this district. Mount Iriga, around the lower slopes of which the abacá "lates" or farms are situated, is an old volcano forming a part of the chain of volcanoes which extends in a northwest and southeast direction. It lies about mid-



PLATE 1.—LABORER'S HOUSE SURROUNDED BY ABACA PLANTS, MOUNT IRIGA, AMBOS CAMARINES, LUZON.



way between the volcanoes Isarog and the Mayon or Albay volcano. Of less elevation than the other volcanoes, it rises above sea level approximately 1,212 meters. The form of the mountain is a symmetrical cone truncated at the top, with the slopes considerably gullied by stream erosion and washing. To the south and west are vast fertile plains formerly cultivated in rice, but at present, on account of the lack of suitable farm animals, these valleys are largely uncultivated.

It is on the north side of Mount Iriga that the cultivation of abacá is carried on most extensively, for on the south the slopes of the mountain possess stony, shallow soils that are unsuited to growing abacá. Apparently, during the last eruptions of the volcano, the winds blew from the south, and all the finer ashes and detritus from the volcano were collected on the north side, and it is from the weathering of these fine ashes and dust that the soils are derived. In places on the north side of the mountain there are areas where the soils are shallow and consist largely of masses of large boulders mixed with sharp, coarse sand; but, over the greater part of the northern slopes, the soils are deep and exceedingly fertile. They consist of soft mellow loams, in places slightly sandy, to a depth of at least one meter, and in many places the soils exceed this depth. There is little change in character or texture between soil and subsoil, and the soils are always deep, 38 centimeters being about the average depth. These soils are rich in decayed organic matter and, even where abacá has been grown for forty years, there is apparently no diminution of the original fertility. Protected from the washing of the heavy rains by the thick growth of abacá and by the always rotting mass of dead leaves and trunks of the plants from which the fiber has been extracted, these soils are kept in a state of almost virgin fertility, for all vegetation is returned to the soil on which it grew except the extracted fiber.

These soils possess excellent drainage, and the hardest rains readily percolate through them on account of the loose, mellow nature of the soil. The color of these soils varies from a purplish red, the color of the rocks and sands from which they are derived, to a yellowish brown and jet black. On the lower slopes the purplish red color predominates, while on the upper slopes the soils more commonly have a brownish or black color. These soils are thoroughly decomposed and contain no trace of the sharp, volcanic dust and ashes from which they are undoubtedly derived. There are some slight variations where the rains have collected into streams and formed slight gullies down the mountain sides. Along such gulches there is found a greater abundance of coarse sand and frequently large masses of boulders and stones brought down from the higher slopes.

Where there is an abundance of stones, or where the soils contain much coarse sand, such good results are not obtained as where the soils are deeper and consequently richer in plant food.

Abacá has been grown in this district for more than forty years and the present prices have stimulated the development of the industry, and new lands, higher on the mountain, are being cleared, preparatory to planting the crop.

The abacá produced in this district is shipped in large, loose bales on *barrotos*, the local name for the long narrow boats used on the Bicol River. Two of these long *barrotos* are lashed together by means of bamboo poles and *bejuco*, and will carry a considerable load of loosely bound abacá to Nueva Caceres. Here it is assorted into the various grades by skilled workmen in one of the large warehouses and rebaled in bundles of 125 kilos each. From this city it is shipped by light draft steamships to Manila and from there to all points of the world.

ALBAY.

At present Albay is the greatest abacá producing province in the archipelago. While the market price does not equal that of the product of Sorsogon or Leyte, still the prices at the present time are so much in advance of several years ago that the cultivation of abacá is practically the only industry in the province, and former crops and occupations are abandoned for the more profitable abacá. The province is fortunate in possessing two good ports, Legaspi and Tabaco, and from these large shipments are of almost daily occurrence. During the year 1900, according to the Monthly Summary of Commerce and Finance, the Province of Albay shipped 30,382,812 kilos of abacá, more than one-fourth of the amount shipped from the entire Archipelago. Large quantities of abacá are gathered in the region adjoining Tabaco, while the towns of Polangui, Oas, Ligao, Guinobatan and Camalig, in the central part of the province, all furnish considerable quantities for shipment. The very finest quality of abacá fiber is said to be grown in the rough and rather inaccessible southwestern part of the province. This is generally shipped from Donsol, in Sorsogon Province, although it occasionally finds its way to the Legaspi markets.

No mention of the soils of this province should be made without some reference to the majestic Mayon volcano, from whose ashes and dust nearly all of the soils of the province are derived. Situated near the seashore, it towers 2,415 meters above the surrounding country and is a noted landmark in navigating the waters of this part of the Archipelago. The cone is considered by many the most symmetrical of any volcano in the world. Numerous instances of damage wrought by its eruptions are recorded by Spanish and other observers and, even during the American occupation, one slight eruption has taken place, although no serious damage was done.

Inasmuch as the soils of this province are derived from similar materials, it is to be expected that they should all be quite similar. Moreover, the soils of this province are also somewhat similar to the soils of the

Mount Iriga district, since all have been derived from volcanic rocks, ashes and dust of similar composition. Volcanic soils are nearly always exceedingly fertile, and the soils of this province are no exception. Seldom are heavy clay soils found in the province, but all variations from light sandy loams to heavy sandy loams and silty loams can be found. Around the foot of the Mayon volcano abacá is cultivated extensively, especially on the northern slopes. The farms do not extend far up the mountain sides, although they reach greater elevations in the vicinity of Tabaco. Usually, the lands around the base of the volcano are not as much sought after as are the small hills and rolling lands further west in vicinity of Ligao, Guinobatan and Camalig. Near the volcano the soils are black, sandy loams, mixed with fine black gravel, and a small proportion of silt and clay. Usually, at a depth of from 25 to 40 centimeters below the surface, a layer of many centimeters of distinctive volcanic gravel and coarse sand is found and, under this, heavier loams and fine sand occur.

In the soils here, as in all the soils of the province, the fine sand is sharp and feels like bits of broken glass mixed with the fine earth. These soils are fertile and support only a fair growth of abacá plants, but the quality is good. In some places around the foot of the volcano the streams are building up great sloping plains of black, loose, coarse sand, so open and porous that only coarse grass, similar to the cogon (*Imperata arundinacea*), can find a footing. These sands would be productive, provided they did not shift and vary their position with each heavy rainfall.

In other places near the foot of the volcano, where larger streams occur, are great boulder trains in places many hundreds of meters in width and containing boulders of dark volcanic rock weighing upward of several metric tons. In one place a cocoanut grove was observed, that was being slowly buried by the great mass of boulders and stones being heaped upon it with each succeeding flood.

From Ligao toward Polangui there are large areas of rice land, but the latter town is the center of a large hemp industry. The quality of fiber, however, does not compare favorably with that of the rest of provinces, but corresponds more closely to that shipped from Daet, the former capital of Camarines Norte.

Between Ligao and Guinobatan the hills and rolling lands are exclusively cultivated in abacá and many fine "lates" are seen. The soils in this section of the province are dark brown and yellowish brown loams, that are composed of fine silt mixed with very fine sand and some sharp gravel and very coarse sand. These soils are rich and fertile, as the large fields of abacá testify. They are easily drained, and even the heaviest rains readily percolate through them. They have been cultivated in abacá for many years and some of the best fiber of the province comes from this section.

On the hills west of the town of Guinobatan a fine quality of abacá is produced and, as noticed in so many other localities, the higher the location the better the quality of the hemp. On the top of one of these hills, perhaps 100 or 125 meters above the town of Guinobatan, a sample of soil was collected, which consisted of a rich dark brown loam to a depth of 25 centimeters, while the subsoil was composed of a dark yellow loam with some sharp angular volcanic glass sand to a depth of 65 centimeters, and at this depth, small gravel was encountered. In a region where heavy showers occur at frequent intervals, such a soil will maintain just the proper heat and moisture conditions, not only for abacá, but for many other valuable crops as well. The underlying gravel beds will insure a perfect underground drainage, while the loamy nature of the surface soil will catch and retain the abundant rainfall. The rapid decomposition, under tropical conditions of a moist and warm atmosphere, of the small particles of sand and gravel, constantly sets free an abundant supply of fresh plant food, so that the fertility of these soils is easily accounted for. In this section of the province many other crops were formerly cultivated, among which may be mentioned flax and wheat, potatoes, sweet potatoes, and corn, but the cultivation of practically all of these crops has been given up.

Between Guinobatan and Camalig a broad sloping plain of black shifting sand is encountered, that has at present little or no agricultural value. The hills to the west of Camalig are used largely for abacá, but formerly some cotton and a fine variety of coffee are said to have been grown. The soils in the neighborhood of Camalig bear striking resemblance to the soils of the other districts mentioned in the province. On the sides and lower slopes of the hills are heavy brown loams, mixed with some sharp sand, while the subsoils are yellowish silty and sandy loams. On the crests of the hills and ridges sandy soils were noticed, that frequently contain alternating layers of dark sand and fine gravel, interbedded with silt and fine sand. Much abacá of a good quality is grown about Camalig, and the region extends many miles to the west of the town. Good abacá properly cared for in this locality will average 2.7 meters in length. It is said that in the year 1892, from Camalig, 312,500 kilos of abacá were shipped each month during the height of the gathering season. Since that time no accurate statistics have been collected from this particular neighborhood.

SORSOGON.

This province contains many districts exclusively cultivated in abacá, and the sale of this commodity constitutes its greatest source of wealth. In addition to the large areas under cultivation, there are also large tracts which are present are rapidly growing up in dense jungle, on account of the scarcity of labor to prepare the fiber for market. The harbor facilities



PLATE II.—FIELD OF ABACA PROTECTED BY NUMEROUS SHADE TREES, SORSOGON PROVINCE, LUZON.

of the province are not of the best, although there are several ports where steamships touch to receive cargoes of dried abacá.

The price realized for the abacá of this province was, according to the market report of September 1, 1902, published in the Manila Daily Bulletin, 27 pesos per picul, as against 26½ pesos for Leyte, and 24½ pesos for that of Albay. The largest shipments are made from Sorsogon, the capital of the province, near which the finest abacá of the entire province is produced.

The largest and finest "lates," or farms, are situated near Irocin, in the southern part of the province, quite near the active volcano Bulusan, but the abacá produced here is more fleshy and, while the plant makes a large growth, the quality does not compare with that produced in other districts near Sorsogon.

The finest quality is said to be grown near the barrio Pangpang or San Ramon, about 6½ kilometers west of the city of Sorsogon. Abacá is grown on the foothills and lower slopes of what are known as the Castilian Mountains, evidently the dissected and eroded remains of a former volcanic group of mountains. The soils for the greater part consist of rich looking sandy loams of a dark brown color, light and loose and always moist and cool, with the abundant rainfall and the protecting shade of many trees with wide spreading branches. The protection of the ever-present mulch of decaying abacá stalks and leaves, as well as the leaves of the shade trees, also helps conserve the moisture in the soil, for in this locality the soils are shallow, seldom exceeding a depth of 60 centimeters. The subsoils are usually heavier in texture, although they nowhere in this vicinity can be called clay loams or clays, for a certain amount of coarse sand is always mixed with the soils as well as subsoils. The sands of the soils in this province have none of the sharp, glass-like edges of the sand found in Albay Province, but they are rather more rounded and worn by atmospheric decay, as well as the wearing action of running water.

Great boulders, often one or two meters in diameter, are found scattered about on the surface, or deeply buried in the soil. These consist of dark colored vesicular volcanic rocks, and it is from these rocks that the soil is being formed by the slow processes of weathering and atmospheric decay. Cultivated in crops that would leave the surface bare the greater part of the year, these shallow soils would soon be washed to lower levels, leaving only bare rock in their place; but, with the thick growth of abacá, the soil is amply protected from the washing effects of heavy tropical rains. Fields of abacá were seen in this vicinity, that are known to have been in cultivation for more than seventy years and, while the yield per hectare has undoubtedly greatly decreased, the quality of fiber has correspondingly increased, and this region produces white abacá of a fine quality.

From Sorsogon northward toward Bacón, considerable abacá is grown, and of fine quality. Here the plant is grown on a slight plateau, nowhere perhaps exceeding 30 meters in elevation. From Sorsogon the country slopes gradually northward, but near Bacón the change in elevation from the sea level to the upland is more abrupt. In this vicinity the soils approach in character those that have been described as occurring in the Mount Iriga district of Ambos Camarines. The soils are rich mellow loams of dark color, with subsoils consisting of loams of similar texture and composition, but of a decided yellowish color. In some places the soils become more sandy and grade into still more sandy subsoils. In places, considerable numbers of bowlders are scattered about on the surface. Where the soils consist of the mellow loams large and well kept fields of abacá were noticed and, on account of the nearness to the cities Sorsogon and Bacón, little difficulty is experienced in getting sufficient labor to prepare the fiber for market. When so prepared, it is hauled in carabao carts or packed on the backs of carabaos to Sorsogon, where the work of resorting, grading, and baling is carried on.

Southeast of Sorsogon, just north of the mountains that form part of the series which surround Bulusan Volcano, is a broken and eroded tableland, where many large and extensive abacá fields are seen. The quality of the fiber does not compare favorably with that of many other sections of the province, and many large fields can be seen that are uncultivated on account of the lack of suitable help. This broken and eroded plateau is more than one hundred meters above sea level and descends abruptly on the Pacific Coast side. The soils of this plateau are uniform in character, and are heavier in texture than any observed elsewhere for the cultivation of abacá. In many places the soils were in poor condition; that is, they contained excessive amounts of acid and smelled badly, and showed plainly the ill effects of imperfect aeration and lack of proper cultivation. The soils of this section of the province consist of closely compacted heavy loams to a depth of 15 to 22 centimeters. The subsoils are heavy clay loams of a yellowish color. From the heavy character of both the soil and subsoil, good underdrainage could not be expected, and frequent stirring of the surface soil should be resorted to, to prevent the top soil from becoming compacted and rendered impervious to water. With deep plowing and the application of green manures, these soils could be made very productive; but, in their present condition, they are not well adapted to producing the best results with abacá. These soils have apparently been derived from volcanic rocks, presumably from former lava flows. The soils are two or three meters in depth and only in places can the parent rock from which the soils are derived be detected. In many places in this region large bodies of land are frequently connected with each other by very narrow necks of land and, from the general level of the

remnants of the once continuous plateau, one descends to flat, swampy bottoms by steep, precipitous slopes of 20 to 50 meters. On these bottoms attempts have been made to cultivate rice in some places. In other localities the blue clay soils of these bottoms are too wet and swampy to admit, in their present condition, of any cultivation whatever.

When the conditions of soil and climate are considered, it is seen that they are very favorable for the cultivation of abacá in Sorsogon Province. The natural conditions are so favorable, with some minor exceptions, that, with the proper adjustment of transportation facilities and labor conditions, the cultivation of abacá should become a far greater source of revenue than at present.

SAMAR.

In this province only very limited opportunity was given to observe the abacá soils. The capital, Catbalogan, as well as the city of Calboyog, are probably the most important shipping points for the abacá produced on the island. But little abacá is produced near these cities, the supply coming from the hills in the interior. There are practically no roads on the island, so the abacá is carried down the rough trails to the large rivers, and from there shipped to some of the larger towns for reshipment to ports where large vessels touch. The finest quality of abacá is said to be produced in the northern part of the island, but a good quality of fiber is produced in the hills along the Gandara River. There are many good abacá producing districts, but the transportation question is often a serious one, on account of lack of roads. The country is sparsely populated, and its unsettled condition for the past few years has seriously operated against the attention being given to the cultivation of abacá that it deserves, so that many plantations have been allowed to grow up in jungle. Very recently, however, more abacá is being prepared and is coming to the markets in considerable quantities.

On the west side of the island there is considerable uniformity in the soils. In the hills about Catbalogan, for several kilometers eastward from the coast, the soils consist of heavy yellow clay loams that are underlaid by a yellow clay loam of heavier texture. At a depth of something over 60 centimeters the clayey subsoils grade into a loose, sandy mass of decomposing rock. These soils easily become compacted, rendering them impervious to the ready passage of rain water. In the narrow trails this clay becomes, during the periods of greatest rainfall, wet and slippery, making travel over them dangerous and at times well-nigh impossible. These soils in large areas are at present only used for growing small patches of corn, upland rice and sweet potatoes. They are apparently derived from calcareous sandstones, although granite of fine quality and texture is found in the central part of the island, and has been reported as

giving rise to similar clayey soils. Along the western coast, in the neighborhood of Catbalogan, limestones crop out and the soils are heavy clay loams and clays. On the east coast of the island the soils, instead of being heavy clay loams, are reported to be more loamy in character, and correspondingly more rich and fertile. Consequently, on the east coast of the island cultivation of the land is carried on to a greater extent, and extensive rice fields are found, as well as some sugar cane. Much of the island consists of unbroken forest, and many years must elapse before any great advancement can be made along the lines of successful agriculture.

LEYTE.

From Leyte a fine quality of abacá is shipped, and for many years the island has enjoyed the reputation of being one of the foremost abacá producing districts of the entire Archipelago. The finest quality of abacá is probably that produced in the extreme southern part of the island, in the hilly region adjoining Malitbog Bay. The northeastern part of the island has for a long time also been known as a fine abacá region. In this section of the island the greater part of the abacá grown is found on long, gently sloping lowlands, rising gradually back to the mountains in the interior of the island. In none of the abacá producing regions mentioned so far has the cultivation of abacá been successful on such land, but the level or sloping lands are the rule in northeastern Leyte. These lands are not marshy, but are said to be cool, and to possess the abundant rainfall and moisture which the plant thrives best upon, with the limited cultivation it receives. The soils of this section of the island, while not clayey, are heavy silt loams and, from their texture and composition, would make excellent sugar lands, except for the prevalence of great swarms of locusts at times. These silty loams are alluvial in origin and are rich, fertile, and of considerable depth. Further inland there is a gradual transition to more sandy soils, until the heavy silty soils are entirely replaced by heavy sandy loams better adapted to producing a finer quality of fiber, but with a greatly diminished yield. The sandy loam soil possess heavy sandy loam subsoils and, in places, there is a slight admixture of gravel. The character of the sand and gravel is that of water worn and water deposited material, and unlike the sharp sands and gravels of Albay Province. The sands and gravels are undoubtedly derived from rocks of volcanic origin, for it is a well known fact that there are several old volcanic cones in the center of the island. From the abacá regions in the northeastern part the extracted fiber is packed on carabaos to the nearest coast towns and shipped from there in small sailing vessels to Tacloban or Carigara. At these ports it is assorted, repacked and baled or shipped direct to Manila by large steamships. The mountainous island Biliran also belongs to this province, and abacá is produced in considerable quantities on the entire island.

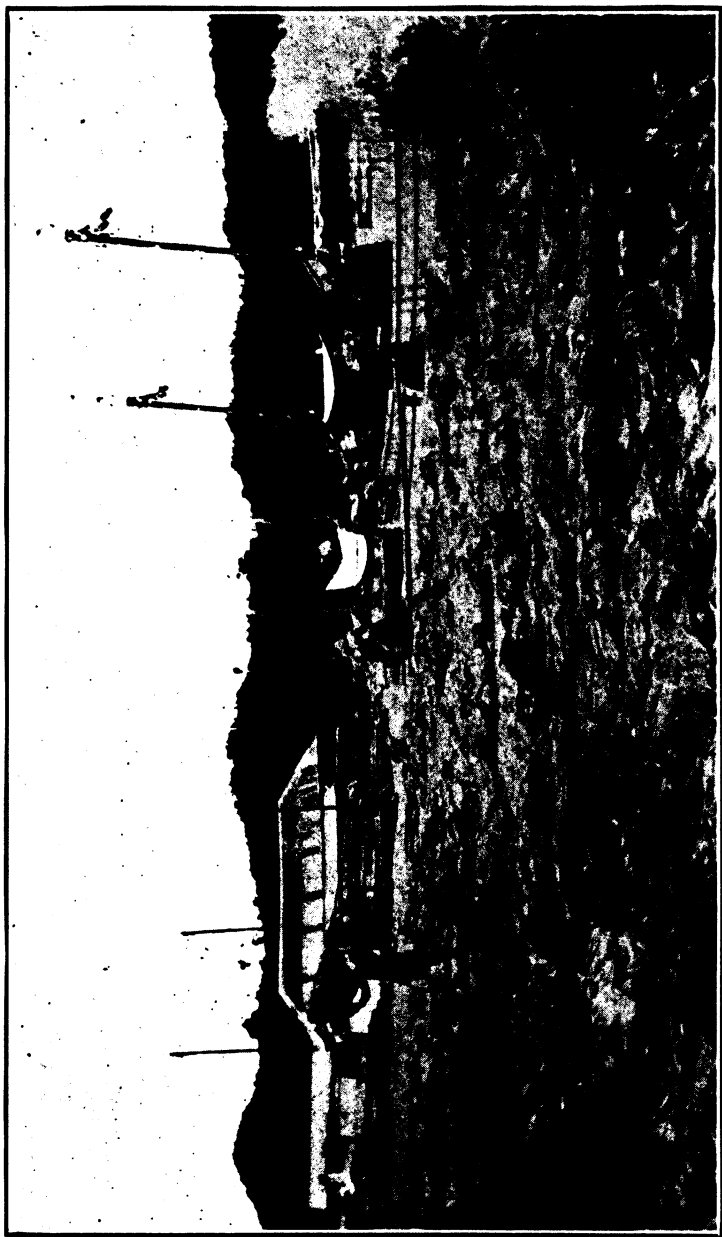


PLATE III.—UNLOADING LOOSELY BOUND BUNDLES OF ABACA FIBER FROM SAILING VESSELS AND SPREADING IT TO DRY IN FRONT OF LARGE WAREHOUSES, TACLOBAN, LEYTE.

OTHER LOCALITIES.

In addition to the provinces just mentioned, there are many other islands or parts of islands where considerable abacá is cultivated, and where large sums of money are realized from the sale of the extracted fiber. Up to the present there has been no opportunity to study the soils of these localities, so little more than the mere mention can be made of these districts.

Marinduque, one of the smaller islands just west of Tayabas Province, has long been noted for the fine quality of extra white abacá produced. The fiber is short, but of a quality well adapted for weaving purposes. The surface of the island is rough and mountainous, and the large mountain in the extreme southwestern part of the island is undoubtedly an extinct volcano.

Mindoro, the large island just south of Batangas Province, annually exports a small quantity of abacá fiber. The island is sparsely settled, but the cultivation of abacá is said to be increasing each year. The surface of this island is quite rough and broken, and there are many high mountains, the most noted of which is Mount Halcon.

Masbate produces limited quantities of a fair quality of abacá. The island is rough and mountainous, and the cultivation of this valuable fiber could be considerably increased.

Panay.—Only small quantities of abacá are exported from Panay, and this is not of a good class, as the fiber is inferior in quality and of short length. The largest shipments of abacá from the island are probably those from the province of Capiz.

Negros.—In this island the cultivation of sugar cane takes first rank, but considerable abacá is also produced. The southwestern part of the island is said to be the part producing the greatest quantities. In middle Occidental Negros some abacá is raised. The hills are all far inland, near the lower slopes and foothills of the central chain of mountains, at an approximate elevation of 300 meters above sea level. In some localities abacá is found growing on reddish gravelly soils. These soils consist of heavy loams, and contain much sandy broken rock rather than river gravel. These locations are on the summits of outlying foothills. The fiber of the abacá grown in these soils, while of short length, brings a good price on account of its extra quality. Again, in the same part of the island, abacá is grown to some extent in virgin forest in dense shade on the lower slopes of the mountains. In these locations the yellow clay soils were overlaid by 5 or 8 centimeters of black, decomposed vegetable mould. The shipment of abacá from the entire island is small, as compared with such provinces as Albay, Sorsogon, Samar and others.

Cebú.—A large amount of abacá fiber is exported from the city of Cebú, that is produced elsewhere; as, for example, much of the abacá grown on

western Leyte. The total shipments made from this point during the year 1900 were less than one-tenth of that from the Province of Albay. The cultivation could be greatly increased and shipments made direct from Cebú to foreign ports of the rebaled and assorted fiber, thereby saving the cost of reshipping in Manila.

Mindanao.—From this large and important island large quantities of abacá are annually exported and, by comparing the number of kilos exported during the year 1900, as given in the Monthly Summary of Commerce and Finance, it is seen that the figures about equal those of Ambos Camarines and Samar Provinces. In the northern part of the island abacá is largely cultivated, as well as in the southwestern part. In the southwestern part the abacá is grown on soils of alluvial origin; that is, they are the result of the overflows and deposition of the sediment carried by the streams. They are rich, heavy loams, composed largely of silt, with a high percentage of decomposed organic matter. The lands occupied by these soils are nearly level, sloping very gently to the seaward. Abacá is cultivated to the water's edge along the coast. In soils of such natural richness and fertility as these, the natural tendency would be to a rank and rapid growth of fleshy plants, although the quality of fiber would not be of a high grade.

Basilan and Jolo.—In these two small islands abacá is also cultivated to some extent. The sites chosen for abacá are low places of much the same character as in southwestern Mindanao. It is rarely grown in the hills, but in low areas that have rich, silty soils of alluvial origin.

CLIMATIC CONDITIONS.

While the number of stations recording the rainfall and temperature conditions of the principal abacá districts is small, still there are some features brought out by these records that deserve mention. The climate, for the greater part of the regions of the Archipelago at present known as abacá producing districts, is not characterized by a pronounced wet and dry season as is western Luzon and Panay and Negros. In these districts the distinction is decidedly marked. There, according to tables given on page 225 of Volume IV of the Philippine Commission Report, from three to ten times as much rain falls during the wet season as during the dry season. On the other hand, in the regions producing the greater part of the abacá exported, the rainfall of one period of the year nearly equals that of the other six months of the year. In Albay, one of the greatest abacá districts in the Philippines, one frequently hears the remark that the rainy season lasts the entire year. The rainfall exceeds 2,960 millimeters (118 inches) and, while some portions of the year receive more rainfall than others, yet rarely does a week pass without a heavy shower. Little provision is made by the natives to store the water and, when a period of two weeks elapses without rainfall, the people are subjected to great inconvenience for their water supply. While the rainfall of this

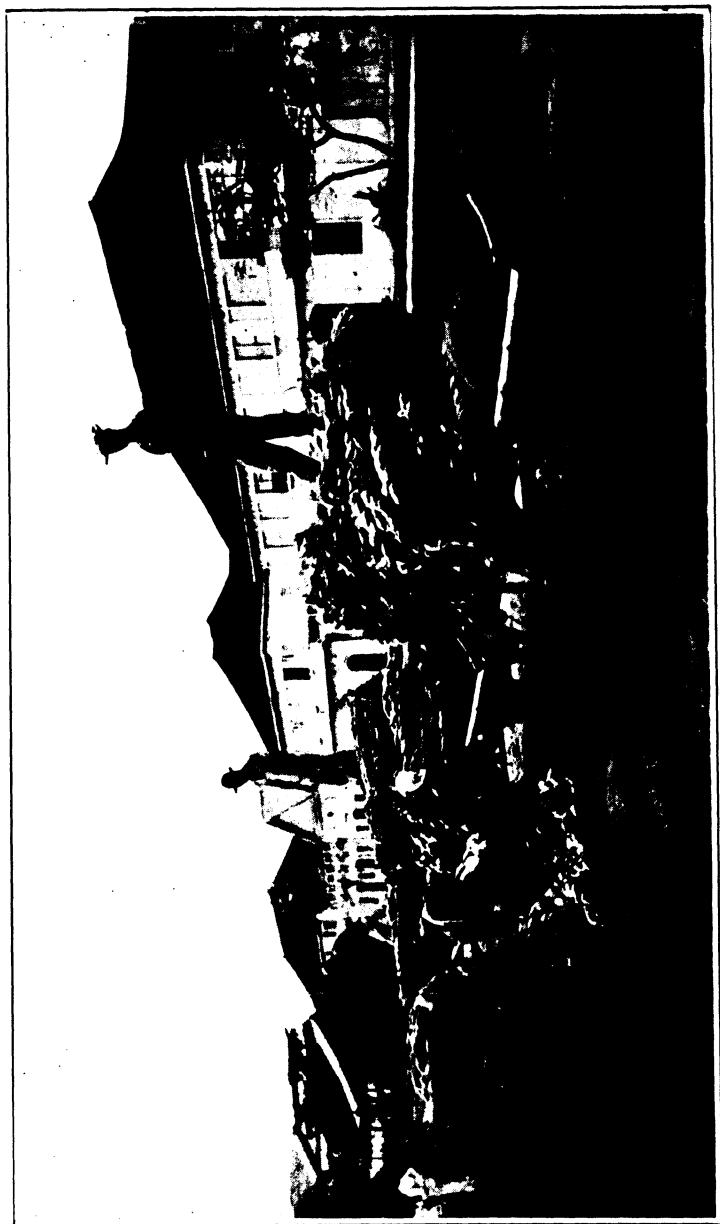


PLATE IV.—HAULING DRIED ABACA FIBER TO WAREHOUSES FOR ASSORTING AND BALING.

province is greater than that of any other of the abacá localities, still the rainfall is distributed in much the same manner during the entire year.

It is this regular distribution of the annual rainfall that controls in a great measure the development of the abacá industry in the Philippines and, with the present system of cultivation, it is to be doubted if the industry could be introduced in other sections of the Archipelago, where the wet and dry seasons are pronounced, unless a radical change is made in cultivating the plants. A period of six weeks' drought will affect the character of the abacá plant considerably, but will not inflict serious damage; but longer periods of extremely dry weather injure the fiber as well as the rapid growing young plants. Frequent rains, sufficient to keep the soil cool and moist, and heavy dews, which often are as effective as light showers, are the requisites of the climatic conditions best suited to the successful development of the plant. Rich, heavy sandy loams are to be preferred over other soils, for these allow the ready percolation of the rain waters through them and the free circulation of the air so necessary to keep soils in good condition. Soils covered with large bowlders are to be avoided as much as heavy, close impervious clay soils. Sloping lands that are so situated as to be, on account of their location, free from destructive winds, are much to be preferred, rather than flat lands.

As to the question of cultivating the soil to conserve the moisture and the planting of leguminous crops to increase the supply of nitrogen in the soil, beside adding large stores of organic matter, these are questions that at the present are altogether untried. Much can be done by proper cultivation of the soil, selection of those varieties of plants that are known to yield a fiber of a superior color and strength, pruning of unnecessary suckers, so as to allow only the best plants to come to maturity, more careful judgment of the best soil to mature no more plants than can be done with the best results as to quality and length of fiber, etc. These are some of the matters that need careful attention in the future development of the industry. The question of fertilizers is an altogether unknown field. No attention has been paid to them; hence, it is not known whether the soil is so exhausted that the application of limited amounts of fertilizers would sufficiently increase the yield to justify their application. In many areas the fields have been cultivated for scores of years, and certainly the original supply of plant food is greatly diminished, but the question of the cost of fertilizers and the increase in yield can only be determined by experimentation along careful lines. The question of shade and protection trees needs consideration. It should first be demonstrated that they are essential; next, the number and character of trees best suited to the plant should be determined and an effort made to introduce only such trees as are beneficial, instead of choosing at random certain trees to be left standing when new lands are cleared.

Given the proper cultivation and selection of areas suitable for the growth of the plant, it yet remains to be seen whether or not the in-

dustry can be profitably introduced in other parts of the Archipelago. While suitable soils can be found, the climatic conditions are adverse in large areas of the island; but, with the abundant and cheap water supply for irrigation that exists in so many districts, and cultivation that will help maintain suitable moisture conditions, not only during the dry season but the wet seasons as well, the industry might be introduced in many districts and become as great a source of wealth to the people as in the provinces, where it is already cultivated.

SOIL CONDITIONS OF UNION PROVINCE, LUZON.

Union Province is the southernmost of the long, narrow provinces on the western coast of northern Luzon. On the north is the province of Ilocos Sur; to the east Lepanto and Benguet; to the south Pangasinan; while on the west it is bounded by the Lingayen Gulf and China Sea. Union lies between $16^{\circ} 8'$ and $16^{\circ} 56'$ north latitude, and $120^{\circ} 15'$ and $120^{\circ} 50'$ longitude east of Greenwich, according to data published in 1891 by the Spanish Institute of Geography and Statistics. The same authority gives the area as 2,008 square kilometers. The province is traversed from north to south by high ridges of mountains, broken at intervals by large rivers. The capital, San Fernando, possesses one of the best harbors on the western coast of northern Luzon. Along the coast the principal towns are situated, connected with each other by carriage roads.

The principal crops produced are rice, tobacco, cocoanuts, sugar cane, cacao, sweet potatoes, and peanuts. Only tobacco is grown in sufficient quantities for export. In the rougher, more mountainous portions of the province, much upland rice is grown, and large quantities of sweet potatoes. The rainfall and temperature conditions are similar to those of the other provinces in this portion of Luzon; namely, a distinct dry season of little or no rainfall, and a pronounced season of heavy rainfall. During the months of December, January, February and March, only a few millimeters of rainfall are recorded, while during June, July, August and September the total rainfall exceeds 2,000 millimeters.

The Ilocanos comprise the population of the country along the coast; but farther east in the higher mountains are found scattered rancherias or settlements of Igorrotes.

PHYSIOGRAPHY.

The surface configuration of the province may for convenience be divided into four types, namely: (1) The coastal plain region bordering the China Sea; (2) the coast range of hills; (3) the broad interior valleys; and (4) the mountain ridges and chains with their narrow valleys in the eastern part of the province.

The coastal plain region.—Extending the entire length of the province is a well defined plain fringing the China Sea from a few meters in width to more than seven kilometers in width. On the landward side this



PLATE V.—COCOANUT GROVE, UNION PROVINCE.

plain terminates abruptly at the foot of the steep hills just referred to as coast ranges of hills. Often these plains are quite level and only elevated a few feet above the water's edge; again, they may slope gradually from the base of the hills to the sea, or may be broken by large areas of swamps which have no connection with the tides. From the character of the materials comprising these deposits, they are undoubtedly of sedimentary origin, and apparently prove that this portion of Luzon is rising at the present time.

The coast ranges of hills.—These stand out in bold contrast to the level plain bordering the sea; but, seen from the sea, they attract little notice on account of the extensive ranges of mountains farther to the eastward.

The division of coast hills and mountains is somewhat arbitrary, for no sharp line can be drawn between the coast hills and mountains. Coast hills, as referred to in this report, are the elongated narrow ridges traversing the province in a northerly and southerly direction, and seldom exceed 300 meters in elevation. On the seaward side they are steep and precipitous; to the east they follow each other in rapid succession with intervening narrow valleys. These hills have been carved out of a sloping plain, composed of volcanic tuffs, sediments and coarse conglomerates. They belong to a much older period than the comparatively recent coastal plain. Near the sea these hills have an elevation of little more than 30 meters, but each ridge farther inland stands out in bolder relief, until the long winding ridges insensibly merge into the higher chains of mountains.

Interior valleys.—At varying distances inland from the seacoast, broad valleys open out, forming a pleasing contrast to the long, narrow ridges of the coast hills. Such valleys are found east of San Juan, a short distance east of San Fernando and about Naguilian and other places, where the main rivers which arise in the higher mountains are joined by lateral tributaries which receive the drainage from the coast hills. These valleys are quite level, with sometimes well-defined terraces and slightly marked changes in elevation. They are situated but a few meters above the level of the river; consequently, during periods of great rainfall, they are subject to overflow which at times greatly damage the growing crops. These valleys contain some of the richest farming land of the province. They have been constructed by the gradual accumulations of sand and silt deposited in times of high water. None of these valleys contain more than a few square kilometers and seldom lie more than 20 meters above sea level.

Mountain ranges.—The eastern part of the province is rough and mountainous, and only a few winding, rough trails traverse this country. The valleys are few and narrow, and the small, turbulent rivers run through channels filled with bowlders of all sizes. While farther east the mountains broaden out, forming elevated plateaus, in this province

the mountains consist of scattered peaks and connected ranges of mountains whose summits attain elevations as great as 1,500 meters. These ridges are steep and precipitous and generally thickly forested, except where the Igorrotes have made small clearings for rice fields and sweet potatoes.

SOILS.

An examination of the soils of the province shows marked differences in their agricultural value, their adaptation to various crops, in their composition and texture as well as in the manner of their formation. As the surface features have been referred to as coastal plain regions, etc., the soils of these various physiographic divisions may be described in the same order.

Coastal plain soils.—The soils along the seacoast consist of sand and silt in varying proportions. At the very water's edge are usually found sandy soils, loose and incoherent, composed mainly of loose sand mixed with greater or less quantities of organic matter. In some places, as just south of San Fernando, the driving action of the monsoons has blown this sand into heaps or dunes, and these shifting dunes have traveled inland fully one-third of a kilometer. Such dunes or drifting ridges of sand support only a scant covering of scattered tufts of grass. Where the action of the winds is less potent, and where the sands contain more of the elements of plant food, cocoanut trees succeed quite well, and the remark is often heard in many parts of the province that the nearer the seashore the sweeter and richer the cocoanut.

Back of this line of sand dunes are frequently found low, marshy areas, filled with standing water the greater part of the year. Occasionally, these low swamps extend nearly to the foot of the first range of coast hills. Many of these low swampy lands would make excellent soils if properly drained and cultivated. Where the position is not too low and the soil consists of silt or sandy loams instead of the heavier clay loams, these tracts would produce fine groves of cocoanut trees. On the higher level or gently sloping lands of this region, soils are found of sand, silt, and clay in varying proportions. Generally speaking, the soils of this part of the province are heavy, silty loams, to a depth of a few meters. They are of dark color and are rich in organic matter. They are undoubtedly of alluvial origin and represent the finer sediments of slowly flowing currents of water. In many places the method of plowing while the land is covered with water has puddled the soils so badly that water percolates through them very slowly. These lands are cultivated to some extent to sugar cane, and the low-grade sugar made in this section finds a ready market at a fair price in the local markets. Little attention is paid to the cultivation of the crop, and still less care is bestowed on the selection of the most successful varieties of seed cane. Rice and tobacco are alternately grown on large tracts of these heavy loams. Rice is planted just

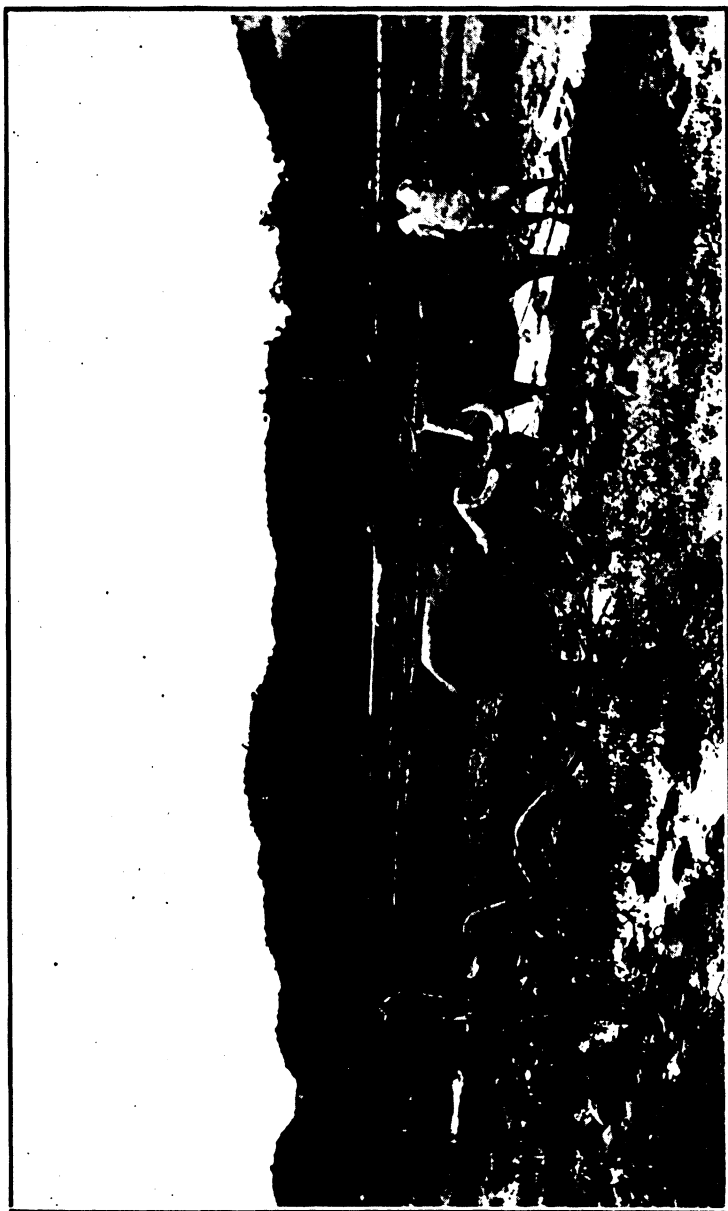


PLATE VI.—PLOWING FOR RICE, UNION PROVINCE.

at the beginning of the rainy season, and tobacco immediately after the rice harvest. While these lands, on account of their texture and location, are excellent rice lands, the same can not be said about tobacco; for the proximity of these lands to the sea makes them of little value as tobacco lands. Tobacco grown here has poor combustibility, and is of poor quality, although much of it is annually exported from the province, as well as supplying a large local demand.

The higher, better-drained portions of the coastal region possess excellent soils for cocoanut cultivation and, in addition to large plantings in cane, rice, and tobacco, many groves of thousands of trees are scattered along the coast. The cocoanut industry is a profitable one to the province, although no exports are made of either oil or dried copra. In the further extension of the industry, special attention should be given to the proper cultivation of the land, both before and after planting the trees, as well as the application of proper fertilizers known to give the best results on cocoanut land. The selection of those nuts from trees known to yield large numbers of fine cocoanuts should also be given much care.

These lands along the coast are thickly settled, and by far the greater part of the population of the province live in the pueblos or barrios situated at short intervals near the seashore. A carriage road traverses the entire distance of the coastal plain country; but, in the rainy season, the absence of bridges over the principal rivers and the soft materials of which the roads are constructed, render travel practically impossible for all wheeled vehicles.

Coast hill soils.—The soils of the steep, narrow ridges and hills bordering the coastal plain make a poor showing, when compared with those of the latter district. In texture the soils range from heavy loams and clays to coarse masses of gravel firmly embedded in a tenacious loam or clay. On the steep, almost precipitous slopes the soils are shallow and in many places devoid of any covering of vegetation, for the heavy, dashing rains easily uproot any chance plant or tree that may attempt to gain a foothold. In the southern part of the province these bare, washed places on the steep hillsides are specially noticeable, and many such places can be counted within a distance of a kilometer. About San Fernando, on the steep hillsides, the prevailing soils are gravelly loams, which are constantly slipping farther down the slope. Frequently, the soft, slippery rock known as volcanic tuff (fine volcanic detritus deposited in quiet waters) outcrops on these slopes and, as soon as small rock particles are set free, are washed to lower levels. On the more gentle slopes, and frequently on the summits of these ridges, soils of considerable depth are found. They represent the products of long-continued decomposition of the underlying rocks, whether they consist of volcanic tuff or loosely cemented beds of well-rounded gravel.

Where the soils have been derived from the fine sediments composing the tuff, they consist of heavy clay loams, stiff and tenacious. Again,

where they contain considerable of the rounded gravel, they are stiff and intractable, on account of the clay in which the gravel is embedded.

Where deep clay soils predominate, good fields of upland rice were noticed or, when not in cultivation, are covered with short, thick-set grass, suitable for pasture. Where the soil covering is shallow, many large patches of the long, coarse grass known as cogon (*Imperata Arundinacea*) and other varieties of coarse grasses occur.

Where the soils are thin and poor, to improve the agricultural conditions of these hills is a serious problem. In many places small clumps of bamboo are noticed. This is said to be a variety that can be utilized in building houses and for other purposes. Near the larger towns the demand for bamboo is sufficiently large to warrant devoting more attention to growing bamboo on these hills. The cultivation of bejuco is also to be recommended on these hills. Farther inland, where the summits of the hills are broader, a more extensive cultivation of upland rice would prove profitable, for many fields were noticed that were flourishing and promised good returns. At present not more than 10 per cent of the area of these hills are utilized for agricultural purposes, and in many cases the soil conditions are so poor that no great agricultural advancement can be expected until all of the more fertile tracts of land are more thoroughly cultivated than at present. Many of these hills present problems for the forester rather than for the farmer, for good timber trees will pay better than many crops grown at considerable expense.

Interior valley soils.—These contain soils quite similar in character and agricultural value to those of the coastal plain region. Near the large rivers in these valleys, there are often long stretches of coarse sands which have little or no agricultural value at present. Such lands are seldom more than two meters above the level of the river and are overflowed many times each year. Often wide stretches of gravel may be found occupying a similar position with reference to the river. By far the greater part of these valleys possess heavy silt loam soils, to a depth of a few meters. These soils are dark colored and are of lasting fertility, for each year they are usually overflowed, and a slight amount of silt and fine sediment is deposited, which helps to enrich them. Some variations, from finer to coarser grades of silt and sand, are noticed in the soils of the various parts of these valleys, but usually there is considerable uniformity in their texture. These lands are well adapted to the growth of sugar cane, but the few fields noticed were not in fine condition, on account of improper cultivation of the soil and lack of attention to the subsequent cultivation of the growing crops of cane. Rice and tobacco are the principal crops, and one crop of each is raised during the year. The tobacco is planted shortly after the rice crop is harvested at the close of the rainy season; good yields of rice are produced and the lands are considered fine tobacco lands, but the quality of leaf grown does not compare with the finest products of the Cayagan valley in northern Luzon.



PLATE VII.—RICE LANDS IN INTERIOR VALLEY, UNION PROVINCE.

The tobacco grown about Naguilian is well spoken of and commands a much better price than that grown near the seashore. But little attention is paid to the selection of seed, while methods of preparing the soil, cultivation and curing the harvested crops, are crude and can not be expected to produce the finest kinds of tobacco. About the houses of the richer class of people a number of cacao trees are usually noticed that thrive and produce well. These furnish the family with sufficient chocolate for its own needs, but seldom is enough produced for export, even to the nearby village markets. The same remarks apply to limited crops of coffee grown in the yard about each farm house.

Mountain range soils.—The mountain ridges and peaks possess soils totally unlike any of those previously mentioned. Except on the steepest slopes, the soils are deeper, and fewer bare rock surfaces are found. Many boulders are found scattered over the slopes in places, but these are seldom in sufficient numbers to seriously injure the value of the land. The soils are usually of a soft unctuous clay to a depth of one or two meters on the more level portions of the slopes and summits. This clay is of a decided red color, and exceedingly well drained for a soil containing so high a percentage of clay. While this soil will retain a great amount of water, yet it readily allows the passage of rain water through it, and, within a few days after heavy rains, is in fair condition for cultivation again. On the slopes the soils are of a yellowish color and, while soft and clayey, are not so heavy nor is the depth of soil so great. In forests the depth of rich dark brown loam often exceeds one-third of a meter. Both of these classes of soil have been derived from the underlying rocks by the slow processes of rock disintegration and decay. In weathering under the action of atmospheric decay, the rocks frequently weather in concentric rings and the harder portions are thus left as well-rounded boulders, which are scattered about on the surface and wholly or partially buried in the soil itself.

The rocks from which these soils are derived are all of volcanic origin, and some of them are undoubtedly volcanic dust and ashes that have been deposited in quiet water.

The red clays and yellowish clay loams are fertile but, on account of their heavy character, need thorough cultivation to realize their true producing value. In the narrow valleys are found small strips of alluvial deposits of sand, silt, gravel and even large boulders. These have, on account of their limited extent, comparatively little agricultural value. All such tracts are subject to overflows during periods of heavy rainfall, which may cause the rapid streams to rise several meters in a single day. Large areas of this mountainous land are lying idle and covered with a thick growth of cogon and other grasses; besides, there are also immense tracts that are as yet uncleared. Some relatively small areas are in cultivation by the Igorrotes, who grow fields of upland rice and

sweet potatoes. Both of these crops produce well, and the yields would seem to warrant a considerable increase in the acreage planted to these crops. Some wild abacá occurs along the slopes in the forests. In the rancheria Dis-Dis fiber has been extracted and pronounced of good quality, and it was recommended at the time that the cultivation of abacá should be extended. Transportation is a serious problem, with the cultivation of any crop, in a region so mountainous, and where trails are so few in number and so wretched in character.

SUMMARY.

In Union Province, then, we find there are many varieties of soils, varying in agricultural value. The most valuable for farm purposes are the rich alluvial soils of the coastal plain region, and the large valleys of the interior. In the agricultural development and advancement of the province, these regions should receive the most attention, and every square meter of these lands should be thoroughly cultivated before making any great expenditure of either labor or money to develop the poorer soils of the coast hills or higher mountains farther east. Both of these latter regions offer a rich field to the forester, either to preserve the existing forests so that the largest revenues can be realized from the lumber products, or to reforest the now almost barren hills along the coast with trees and shrubs that will enhance their value. Along the coast the cocoanut industry is one that deserves especial attention, for conditions are favorable for the development of a large industry. Experiments with cotton culture should be patiently carried on until they result in success or failure. With the abundance of labor the province affords, an attempt should be made to introduce the tea industry, for there are large areas in the province that seem to promise success to such an industry.

Tea can adapt itself to such a variety of conditions that it should be given a fair *trial*, for its introduction would mean much to the province. Along the line of the rice and tobacco crops, the mainstay of the province, great changes in the yield and quality can be realized by more attention to the best varieties of seed, and to improved methods of cultivation and harvesting.

SOIL CONDITIONS IN PHILIPPINE FORESTS.

In company with Mr. Gifford Pinchot, of the United States Department of Agriculture, Capt. G. P. Ahern of the Insular Forestry Bureau, and others, the author, under the direction of the Chief of the Bureau of Agriculture, made, an inspection tour of some of the principal forest areas in the Archipelago. The party left Manila on the U. S. S. *General Alava* October 29 and returned November 21, 1902, during which time short stops were made at Paluan and Punta del Monte; Mindoro; Caima Bay, Luzon; Palanas, Masbate; Calbayoc, Samar; Silad, Leyte; Point Bulalagui, Cebu; Iloilo; Point Obon, Negros; Santa Maria, Zam-



PLATE VIII.—IGORROTE WOMEN DIGGING CAMOTES, OR SWEET POTATOES, IN EASTERN PART OF UNION PROVINCE.

boanga, and Malabang in Mindanao; Sinaluk Island; Tatan, Tawi Tawi; Bongao; Sandakan, Borneo and Malampaya Bay, Paragua. At the most of these places short excursions were made inland, while at Mindoro and Malabang trips inland occupying several days were made. In all places where opportunity allowed, observations were made on the soils, their origin, manner of formation, fertility, general characteristics, etc., etc. Samples were collected from several localities, which will subsequently be chemically and mechanically analyzed, to throw more light upon them. It is especially to be regretted that, on account of the limited time in each place, the relation of the forest growth to the soils could not be ascertained, for a close relationship between the soils and certain classes of trees will undoubtedly be discovered with careful study.

MINDORO.

From Paluan a trip was made northward to Calavite ridge and return, by way of the Calauagan River. On the north coast, short trips were made southward on the slopes of the same ridge in the neighborhood of the Dioso River, near Punta del Monte.

Paluan is a small town situated in the extreme northwestern corner of Mindoro. Its geographical situation is at $13^{\circ} 20'$ north latitude and $120^{\circ} 30'$ east longitude. Near Paluan and adjacent to the eastern part of Paluan Bay is an extensive area of alluvial land, capable of annually producing 20,000 cavans of rice (81,818 kilos). The soils of this level tract of land consist of a light drab colored loam, composed mostly of silvery white particles of silt and the finest particles of sand. It has a soft, slippery feel to the fingers, leaving them coated with fine silvery particles of white mica. Little or no difference is noticed in texture or color between soil and subsoil. It is a loose, porous soil, possessing good natural drainage and, on account of its loamy character, is easily stirred and cultivated. It contains but a small amount of humus, although it is the result of continued deposition of small particles of sand and silt in quiet, shallow waters. It has been washed from the hills by rains and deposited by the various rivers surrounding Paluan Bay.

It is best adapted to rice culture for, on account of its low position, it readily retains the abundant rains of the wet season. In the higher portions of this tract of land, sugar cane would thrive well; but the present low price of sugar would not warrant the introduction of this crop. A few straggling cocoanut trees were observed and the planting of small groves, it is thought, would be profitable. A few abacá plants were also noticed, but these were in a sickly condition, and produced little or no fiber. The cultivation of abacá is not to be recommended, on account of the pronounced wet and dry seasons. Rice is the crop best suited to this area and, with the abundant water brought in by the small streams, two crops per year could be easily grown, since the present supply does not suffice for the local demands.

On the north side of this alluvial plain, entering the hills, soils of an altogether different character are encountered. The change is distinct and at once remarked. The silvery, silty soils are replaced by soils of a decided red color, filled with angular pieces of broken micaceous rock. On the steep slopes the covering of soil often exceeds but a few centimeters, and even this is filled with fragments of the rock from which it is derived. These red soils are composed of about equal proportions of silt and clay, with some sand, and may be classed as clay loams. On the steeper slopes the rains soon percolate through them and, on account of the character of the underlying rocks, they become dry and compact, even after copious rains. On the more level portions of Calavite ridge the conditions have favored a greater accumulation of soil; hence, they are more retentive of moisture and possess more value for agricultural purposes. On the steep slopes the soils possess little value as farm land, but support a fair growth of forests in which bejuco (rattan) is abundant. On the higher, more level portions of the ridge, the vegetation is more dense, especially the undergrowth. These soils are derived from the slow decomposition of the underlying rocks. Slowly the rocks crumble and fall to pieces and, when thoroughly decomposed by the atmospheric agencies constantly at work, they appear as soft, red clay loams, through which are scattered occasional fragments of the harder parent rock. The rocks which give rise to the soils of the mountain slopes and ridges comprise a series of micaceous, quartose, talcose and chloritic schists. They belong to the older series of geological formations that have been changed and altered by subsequent processes. They consist chiefly of silica, white mica and iron bearing silicates.

In the few cleared areas among the forest growth some fields were noticed that are at present covered with cogon grass. In no places were cultivated fields noticed, for the scattered tribes inhabiting the mountains practice agriculture on a limited scale. Where the slopes are not too precipitous, the soils would be found to be fairly productive and, by proper cultural methods and fertilization, could be made to produce good crops of upland rice, corn, beans, and sweet potatoes. On the steepest slopes it would be folly to attempt any cultivation whatever. In spite of the heavy covering of forest and the ever-present decaying leaves and tree trunks and vines, little or no humus can be detected in the soils.

The forest growth abounds in many of the more valuable woods of the islands and among others may be mentioned lauan, bocboc, tindalo, anti-polo. The baleté is especially common and many of large size were noticed, in some cases completely surrounding the tree, upon which they cling for support.

On the northern side of Calavite ridge the slopes are steeper and many sheer precipices were observed. Accordingly, the conditions allowing the soils to accumulate are not favorable, and shallow, stony soils, similar

in character to those already mentioned, are found. Near the highest point in the ridge, which attains an elevation of about 700 meters, the rocks contain a larger proportion of quartz; hence, the soils are shallower and contain more rock fragments. Near the mouth of the Dioso River there is a flat, about 250 meters in width, consisting of a heterogeneous mass of boulders and smaller ground-up rock debris. On this flat the tree growth was characteristic and contained a generous sprinkling of molave and calantas. Near the stream bed was observed a remarkable example of the casts formed by worms or other burrowing animals. Many of the tubes or casts were 20 centimeters in height, the outside diameter averaging about $2\frac{1}{2}$ centimeters, while the inside opening measured a little less than 1 centimeter. These tubes are composed of a mixture of micaceous sand and silt, such as is deposited by the river in quiet pools. They may be found completely covering the ground for many meters. The effect of such grinding and working over and over the small particles of sand and silt is to grind them smaller, while the action of the acids, secreted by the animals who built the tubes, undoubtedly acts to further dissolve and reduce the size of the rock particles. At the time when these castings were observed, none of the animals who built them could be found, after considerable search; and yet, three months prior to this time, we were informed, they were not there.

CAIMA BAY, LUZON.

In the neighborhood of this bay in Ambos Camarines Province, some observations were made on the soils and rocks from which they are derived. The bay is situated at $12^{\circ} 40'$ north latitude and 123° east longitude. The climate in this part of Luzon corresponds to that of many of the southern islands. The rainfall is well distributed over the entire year, without pronounced wet and dry seasons. Near the entrance to the bay great, chalky limestone cliffs stand out in bold relief, and it is from the weathering of this soft limestone that the soils are derived. The soils bear little resemblance to the parent rock. They consist of black, waxy loams, heavy and tenacious in texture, but rich and of lasting fertility. The top soil averages about 15 centimeters in depth, overlying a subsoil of yellowish brown clay. Usually rock is encountered about 50 centimeters from the surface, while the surface is thickly strewn with various sized fragments of soft, yellowish limestone. The manner in which limestones weather into soils is somewhat different from other rocks. Calcium carbonate, the chief ingredient of limestone, is readily attacked and dissolved by warm rains, especially since it contains carbon-dioxide. So that, the purer a limestone is, the more readily it will dissolve in a region where the rainfall is abundant. The soils, then, represent the insoluble particles of the original rock, mixed with vegetable matter in varying stages of decomposition.

The natural fertility of these soils is shown by the luxuriant growth of large trees and underbrush they support in the natural state. Among

the more valuable timber trees were noticed many molave, narra, pili, lanutan, ligas, dungan and oranga. If the forest growth be cleared, where free from stones and of sufficient depth, these soils will amply repay the extra cost of plowing and subsequent cultivation. All farming operations are difficult in such soils, for they are exceedingly sticky and tenacious; but for certain crops they are very valuable. Fruits thrive well on these soils, and they are natural pasture lands. Corn, tobacco, and vegetables will be found to yield large crops. Near this locality, on black, waxy, limestone soils, considerable abacá is grown, and it is reported that the crop pays well. Coffee does not succeed well, but cacao should make a good growth and bear well.

PALANAS, MASBATE.

Palanas is situated on the southeastern coast of Masbate, at $12^{\circ} 10'$ north latitude and $123^{\circ} 55'$ east longitude. It is a small town, that exports little or no agricultural or forest products. Low hills lie west of the town, that further inland merge into a well defined central mountain region. The rocks of the hills along the coast are soft, whitish yellow limestones, that weather into soils, very similar to those described as occurring at Caima Bay, Luzon. Where conditions for the weathering of these rocks are favorable, a rich, black, waxy, tenacious clay loam has resulted. At an average depth of 30 centimeters, on the more level slopes and hilltops, the soils grade into yellow clays that are soft and unctuous, and possess little or none of the sticky or waxy nature of black loams on the surface. On the steepest slopes and highest parts of the hills, the soils are shallower and a considerable number of partially decayed limestone fragments are scattered about on the surface. Where the soils are deep and free from such pieces of limestone, there can be no doubt of their lasting fertility. While difficult to plow and stir, even with the scant cultivation given them by the natives, they produce good crops of sweet potatoes, corn, beans and the other crops that are planted in limited quantities. Some tobacco is grown, but only to a small extent, and for local consumption. Tobacco makes a rank growth on such soils, but for chewing tobacco and cigar fillers good results can be expected, with proper seed and modern cultural methods. Such soils are especially desirable for corn, cotton, fruits, vegetables of all kinds, while pasture grasses make a good growth entire year, especially in this part of the Archipelago, where the annual rainfall is well distributed. Near Palanas were seen camote (sweet potato) fields, scattering clumps of cocoanut trees and large areas overrun with a dense growth of the coarse cogon grass. A few kilometers from the village, on similar soils, a fine quality of abacá was reported, and some larger fields of tobacco than at Palanas. From all reports, similar soils are found in much of the coast country of eastern Masbate, while in western Ticao, from the character of the low, white, limestone cliffs, it is to be inferred that the same soil conditions prevail.

CALBAYOG, SAMAR.

At Calbayog the soils were examined along the coast for a few kilometers north of the town. Calbayog's geographical position is $12^{\circ} 6'$ north latitude, $124^{\circ} 37'$ east longitude. It is one of the important abacá shipping points of western Samar, although but few large plantations are near the city. North of Calbayog, even within a distance of a few kilometers, several different classes of soils can be found. Near the coast sandy soils prevail, while the same character of soils are found near Calbayog. These consist largely of medium grade sands derived from broken and finely divided coral reefs that have been subjected to the grinding action of the waves. White in color, compact and apparently containing but little of those elements that are essential to plant growth, these soils support large groves of cocoanut trees. Small patches of corn, beans and sweet potatoes are also raised. Farther north from Calbayog, soils are found that may be described as yellow clay loams. With the exception of occasional abacá plants, little is seen on these soils but a heavy growth of cogon grass. They are only fairly productive and closely resemble large areas of yellow clay loam soils that the writer has observed in the hills east of Catbalogan, the capital of the island, about 35 kilometers south of Calbayog. In this locality the soils are derived from the slow weathering of rocks that are apparently calcareous sandstones.

Again, in the low country along the coast north of Calbayog, heavy, reddish, sandy loam soils were observed. These soils, in spite of the large percentage of sand they contain, are stiff and tenacious, and can be cultivated with little less difficulty than clay loam soils. They are undoubtedly residual soils—that is, they have been derived in situ by the slow processes of rock decomposition. They can be classed as less fertile than the yellow clay loams and much stronger and more fertile than the coral, sandy soils along the shore. No cultivated fields were seen, but a few scattered clumps of forest and some areas of cogon grass. Scattered among the patches of cogon grass were noticed many specimens of the Toob tree that grows to a great height.

SILAD, LEYTE.

This is a small barrio belonging to the pueblo of Villaba on the northwestern coast of Leyte. It is situated at $11^{\circ} 13'$ north latitude and $124^{\circ} 23'$ east longitude. Along this portion of the northwestern coast of Leyte, the country is broken and rather high hills, from which the forest has long been cut away, reach to the very water's edge. Farther inland, to the east, are high ranges of mountains that are undoubtedly of volcanic origin, judging from the bits of rock carried seaward by some of the small streams. Near the coasts, however, are soft, yellowish white limestones, similar to those mentioned as occurring in Ambos Camarines Province, Luzon, and on the island of Masbate. These weather into

yellowish brown clay soils, somewhat similar to the soils of the above mentioned localities. The surface soils are dark clay loams that possess none of the waxy quality of the soils of Masbate and Ambos Camarines. At an average depth of 15 centimeters below the surface, the clay loams grade into soft, unctuous clays of a decided yellow color. The subsoils contain a much higher percentage of clay than the soils; in fact, in places they consist of but little else except the finest particles of clay. In the small gullies along the trails, often at a depth of one meter, the clays can be observed resting on the limestones from which they are derived. The surface soils contain a fair amount of humus, while the subsoils add strength and body to the soils, by acting as reservoirs to store up and conserve the moisture necessary for the growing crops. Some fields of upland rice were noticed—a crop that should succeed nicely on the rolling lands along the coast. Abacá fields were also noticed, that are said to produce a good quality of fine white fiber. Small patches of sugar cane, that appeared in a flourishing condition, were also seen. From the growing crops and the general appearance of the natural growth, these soils have every indication of being rich and fertile. Scattered Toob trees were seen, that attain a height of at least 40 meters. On one of the hills overlooking the sea, a small cocoanut grove realized for its owner some share of profits from the sale of tuba, daily collected from the freshly cut flower stalks. The soils of this portion of Leyte, while not so fertile as some of the districts above mentioned, are sufficiently rich to warrant good returns to the farmer who bestows his time and labor upon them.

POINT BULALAGUI, CEBU.

This locality is situated at the extreme northern end of Cebu in $10^{\circ} 18'$ north latitude and $124^{\circ} 3'$ east longitude. In this portion of Cebu the country is low and rolling, with no pronounced difference in elevation. The forests have long since been cleared away, and much of the country is under a good state of cultivation. Here, as at Ambos Camarines Province, and at Palanas, Masbate, soils were found, derived from the weathering of soft, yellowish limestones. Near the seashore there is a slight admixture of beach sand, that has been blown inland a short distance; but farther from the shore the soils are heavy, black, waxy, clay loams, to a depth of 15 centimeters.

The black clay loam is underlaid by a soft yellow clay that, in turn, grades into soft, partially decomposed limestones. On the level tracts of land no stones were noticed, but on the hills and slight knolls the soils are shallow and many fragments of the parent rock are scattered about. In such places the soil has little of the value of the more level areas. The heavy, waxy character of these soils makes them hard to plow and cultivate, but their fertility is sufficient to produce fair crops with the scant scratching which constitutes the present system of cultivation. With thorough plowing good yields of many fruits and crops could be har-

vested. Small patches of corn were noticed, of only fair quality; also sugar cane, that was too thickly planted, and plainly showed the lack of cultivation. Upland rice and beans were also seen and, in the areas where no cultivation was practical, a heavy mat of good pasture grass was everywhere observed. Such soils make good pasture lands, while all kinds of vegetables and many fruits will flourish equally well, with proper care and cultivation. Tobacco, rice, and sugar cane will also be found profitable crops on soils of such natural strength and fertility.

POINT OBON, NEGROS.

A landing was made in the small bay south of this point, in southwestern Negros, and the soils examined a short distance to the eastward. The geographical position of the locality is $9^{\circ} 45'$ north latitude and $122^{\circ} 28'$ east longitude. This portion of Negros is rough and mountainous, and but little cultivation is practiced by the people of the small barrios along the coast. Dense forests and jungles reach to the very water's edge, except in the immediate vicinity of the villages.

On the shores of the eastern part of the small bay are sandy soils, derived largely from coral sand and limestone. Small cocoanut groves and patches of sweet potatoes were noticed, that were flourishing. Farther inland was a dense growth of forest and jungle, and soils of a totally different nature were found. In the low land stony soils were found, that consisted of masses of sandy loam mixed with small, angular fragments of comparatively fresh, volcanic rock. These soils are of little value for agricultural purposes, but support a heavy forest growth. On the slopes of the surrounding hills, yellow loam soils of greater depth and more adapted to farming purposes were seen. These soils are derived in places from the slow weathering of volcanic rocks. On the more level slopes and summits of the ridges the soils are correspondingly deeper and possess a greater degree of fertility. In such locations farming operations could be profitably carried on, for the soils contain some humus, and the texture is suitable for storing the moisture necessary for plant growth. Samples were collected in such a location that, to a depth of 30 centimeters, consisted of rich, brown loam. Upland rice, corn, vegetables, sugar cane and abacá would produce fair yields in such areas.

SANTA MARIA, MINDANAO.

Santa Maria is situated in the northwestern part of Zamboanga Province, Mindanao. Its position is $7^{\circ} 45'$ north latitude and $122^{\circ} 6'$ east longitude. This part of Mindanao is rough and mountainous, and the surface of the country is not well adapted to agricultural purposes. In the locality where the soils were examined, extensive timber cutting is being carried on. The soils consist of shallow, coarse, sandy loams of a yellowish color, that grade into broken masses of soft, partially decomposed rock.

They possess little humus and can not be classed as fertile soils. Where the original forest is allowed to remain, the slopes are protected from the washing of the heavy rains, so that, although possessing but little fertility, they readily support a heavy growth of valuable timber. Even where the forest growth has been removed but a short time, the rains have removed the soil in places, leaving the underlying rocks exposed. This soil is residual; that is, it has been formed by the breaking up and decay of the soft, purplish schists that occur in this region. On the steeper slopes no attempt should be made to farm; otherwise, the soil covering would soon be removed. But, on the more level portions, such crops as are adapted to sandy soils would make some return to the farmer. With sufficient manure and fertilizers, vegetables would mature early and make a fine growth; while tobacco, suitable for thin wrappers for cigars, could be raised. In the more sheltered valleys, abacá and cacao could be profitably grown.

MALABANG, MINDANAO.

From Malabang the trip was made to Lake Lanao, a distance of approximately 33 kilometers. Malabang is situated on the east side of the bay of Illana in the Province of Cotabato. Its geographical position is $7^{\circ} 30'$ north latitude and $124^{\circ} 6'$ longitude east of Greenwich. Lake Lanao is situated in the central part of the Province of Misamis. From Malabang to the lake there is a gradual rise until at the site of the Moro fort, Binidayan, an elevation of 950 meters is reached. The greater part of the distance is through exceedingly dense jungle, in which great trees abound, while the profusion of balet and bejuco and creeping vines adds to the tangle and confusion of the jungle. About Malabang, and also about Lake Lanao, the country has been cleared for many years and open, rolling country is the rule. Over the entire distance the soils are quite uniform and bear a striking resemblance to the famous abacá lands near the Mayon volcano of Albay Province, Luzon. The soils of this region may be described as black, fertile, sandy loams of varying depth. Below Mataling Falls in many places the depth of black, loamy sand is 2 meters, of which the upper 30 centimeters contains a large percentage of well rotted roots and other vegetable matter. Above Matalang Falls the depth of black, sandy loam is much less, and in the vicinity of Camp Vicars, in places, does not exceed 15 centimeters. The black, sandy loam varies in size, from fine, powdery like sand to nicely assorted sand of 2 millimeters in diameter. This sand is generally clearly stratified in shallow bands, and each band is generally uniform in size. Frequently, fine and coarse bands of sand are interbedded together. Even where the coarsest grades of sand occur, it was noticed that the sand would retain a vertical position in road cuts, and not slump down in the manner so characteristic of beach or river sand. This sand is usually rounded or slightly angular and, on closer examination, each particle closely resembles the ashes and bits

of slag around furnaces. It is evidently the slightly weathered ashes and dust of nearby volcanoes, and the source of the material is undoubtedly from some one of the numerous volcanic peaks that lie east of the military road in the vicinity of Butig Mountain. The entire region is one of considerable volcanic activity and Lanao is probably a crater lake. Violet earthquakes are common to this part of Mindanao and on many of the higher mountains and hillsides can be seen the paths of landslides that have swept down, entirely removing the heavy growth of trees and jungle for many meters in width.

In places, the black sands rest directly on dense or vesicular volcanic rock. Again, they rest on a soft, yellowish red clay that has probably been derived from volcanic rock by slow decomposition processes. The line of demarcation between the black sands and reddish clays is sharp and distinct, plainly showing no relation between the two.

To one not familiar with the fertility of soils derived from volcanic ashes and cinders, these soils appear of little agricultural value; but such is not the case. They are wonderfully rich and fertile, although it cannot be said that they would continue so after long periods of hard farming. For many years, however, these soils will be found to be very rich and will produce good crops of anything suited to the climatic conditions of the region. At the lower elevations wild abacá was observed and it would undoubtedly succeed at elevations not greater than 400 meters above sea level. Corn would succeed well, and fruits and many vegetables. About Lake Lanao considerable upland rice is grown and, with attention, this crop should prove a profitable one. Coffee, considered especially fine by the lake Moros, is grown in limited quantities at the higher elevations. In the forests many large trees of several valuable varieties are found, while the gutta-percha tree and rubber tree are native to the forests of this part of Mindanao. In the cleared country about the lake a considerable advancement along agricultural lines is to be expected, unless the earthquakes, of daily occurrence, are to be taken as a warning that this beautiful country may at any time become untenable through the opening of the many volcanic vents that certainly have not long been quiet.

TATÁN, TAWI TAWI.

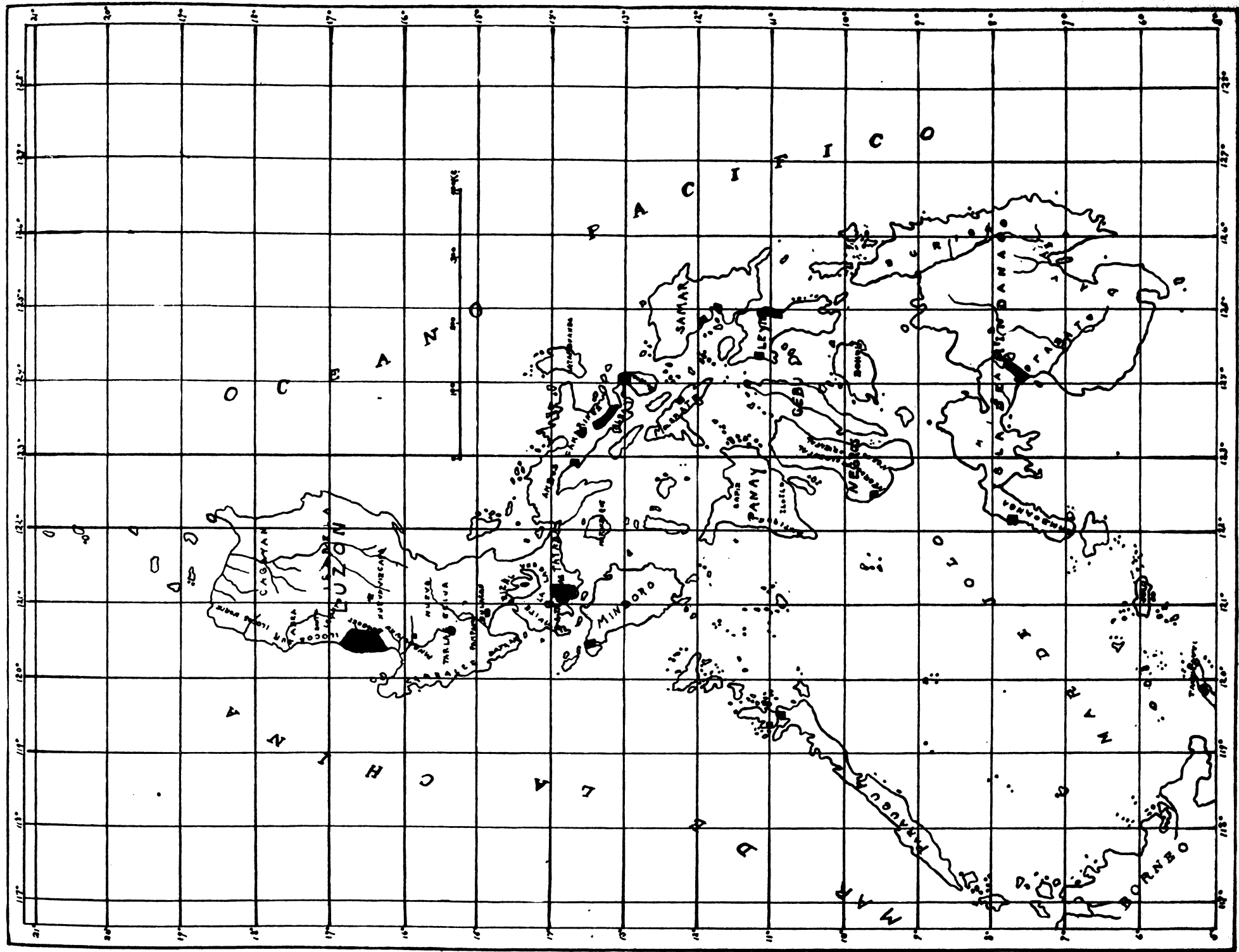
A landing was made on the northwestern coast of Tawi Tawi, at the site of the former town of Tatán. This town was destroyed in 1889 by the Spaniards, and only a few ruins tell of its former existence. The geographical location is $5^{\circ} 15'$ north latitude and $120^{\circ} 3'$ east longitude. To the east of Tatán, in the center of the island, are great perpendicular cliffs that form so striking a feature of Tawi Tawi and the islands south of it. The rocks forming these cliffs are plainly the result of violent volcanic activity. They are termed agglomerates, and consist of angular and broken fragments of various kinds of volcanic rock imbedded in volcanic lavas and muds. Many areas of such rock are found in the Archi-

pelago and, when deeply weathered by atmospheric agencies, they give rise to characteristic soils. The soils are soft, unctuous clays, soft and slippery to the touch, and containing no perceptible amount of coarse sand whatever. In fact, they consist of almost pure clay of a bright red color and, in dense forests, only the uppermost layer is darkened by the admixture of a slight amount of humus. In spite of the great percentage of clay they contain, they readily allow the passage of rains through them and, even after prolonged, heavy rainfalls, soon drain out. To thoroughly plow them is not especially difficult, for the clay is yielding, if cultivated at the proper time. For rice, either upland rice or flooded rice, and for grazing lands, these soils are admirably adapted. Corn, sugar cane and tobacco will succeed fairly well. Coffee, a deep rooted plant, thrives well on red clay lands of this character. In their natural state, a heavy forest growth is the result, in which many valuable timber woods were noticed.

In addition, there was a thick tangle of underbrush and creeping vines, in which bejuco and balete played a large part. No cultivated lands were seen, but some abandoned areas near Tatán were noticed, that were thickly covered with a rank growth of cogon grass.

PANCOL, PARAGUA.

Landings were made at Pancol and Limonancon, in Malampaya Sound, in northwestern Paragua. Pancol is situated on the eastern shore of the sound in north latitude $10^{\circ} 53'$ and $119^{\circ} 28'$ longitude east of the Greenwich meridian. Limonancon is located near the mouth of the sound. This portion of the island is quite rough and broken and so thickly forested that but little land is available for agricultural purposes. The soils about these two villages are quite similar in appearance and general characteristics, and it is to be inferred that the soils of much of this portion of the island are similar. Near Pancol, the soils consist of yellow, sandy loams which on the slopes are shallow, contain but little humus, and can not be classed as rich farming land. On the more level places and in some of the small cleared fields northeast of Pancol, the soils were heavier in texture, deeper, and contained some humus. They were much better adapted to farming purposes, although not very fertile soils. In much of the land covered with forest, the soils did not exceed 25 centimeters in depth before rock was encountered. On the surface are innumerable small fragments of the hard hornstone or siliceous rock, from which the soils are derived. The rock which weathers into these soils is either of volcanic origin, or a metamorphosed sedimentary rock. From the high percentage of quartz it contains, it weathers with exceeding slowness; nor can the resultant soil be rich in the elements of plant food, since the rock itself is so poor in the substances which furnish nourishment to growing plants. The rock is of a reddish color, exceedingly compact and fine grained. The shape of the mountain on the west coast of the sound is undoubtedly that of a volcanic cone, so that it may be reasonably inferred that the rock is



a felsite or acid lava. Upland rice was the only crop grown to any extent on these soils, and only small fields of this were seen. Some small patches of sweet potatoes were also observed. From the stony character of most of this soil and from the rugged nature of the topography in the vicinity of Malampaya Sound, at least, it is not advisable to clear the rich forest growth to attempt to conduct farming operations. On many of the steeper hills so much bare rock is exposed that no improvement could be made unless at the greatest expenditure of time and labor; besides, in the more favorable localities, the soils would need frequent applications of fertilizers to make them productive after continued cropping.

SOIL SURVEY OF THE BATANGAS AREA, LUZON.

INTRODUCTION.

The object of a soil survey, quoting from the Field Operations of the Bureau of Soils for 1901, is to provide an accurate basis for the adaptation of soils to crops. It seeks to present as clearly and as forcibly as possible the conditions of an area in such a manner as to make it possible for prospective settlers to take up lands suited to certain crops, and to enable present owners of land to learn from the experience of other localities what crops are best adapted to their own soils and climatic conditions. In the present struggle for commercial supremacy, the importance of such accurate knowledge of agricultural conditions is becoming daily more evident. No community and no nation can afford to waste its time and energies in the pursuit of interests to which its conditions are unsuited; nor, on the other hand, can it afford to lose any chance of inaugurating and developing those interests for which it is peculiarly adapted.

A soil survey aims to eliminate, to some extent, such waste in the line of agriculture. Its most valuable function is undoubtedly the improvement of existing methods, so that larger yields of our staple crops can be secured, although more showy results are gained in the development of special industries.

A portion of Batangas Province was selected and the soils classified, according to their agricultural value and character, and the distribution of these various classes of soils shown on accurate, large scale maps. Maps made by the Engineering Department of the Division of the Philippines in 1901 were used to project the work upon. These maps are on the scale of 1 centimeter to 0.634 kilometer. They show accurately the location of all roads, trails, rivers, streams, mountains, cities, villages and barrios. The area surveyed is situated in the southern central portion of the province and contains approximately 484 square kilometers. In the following table are given the size of area, the rate surveyed per day and the cost per square kilometer, including the cost of transportation, subsistence and salaries of the men employed. A few areas surveyed by the Bureau of Soils of the United States Department of Agriculture during the field season of 1901 are also given for comparison.

*Area and cost of soil surveys.***Batangas, P. I.:**

Area surveyed	square miles	¹ 290
Rate per day	do	² 8
Cost per square mile		³ \$1.68

Bedford, Va.:

Area surveyed	square miles	632
Rate per day	do	4.7
Cost per square mile		\$2.01

Prince George County, Md.:

Area surveyed	square miles	480
Rate per day	do	2.5
Cost per square mile		\$3.41

Salem, N. J.:

Area surveyed	square miles	493
Rate per day	do	6.2
Cost per square mile		\$1.44

Lake Charles, La.:

Area surveyed	square miles	202
Rate per day	do	2.4
Cost per square mile		\$3.71

Allegan County, Mich.:

Area surveyed	square miles	828
Rate per day	do	5.8
Cost per square mile		\$1.44

The Batangas area lies between 13° 40' and 13° 59' north latitude and 120° 59' and 121° 14' east longitude. It contains the capital city, Batangas, the important town Lipa as well as the smaler towns San José, Ibaan, Quenca, Bauang, Rosario, and Taysan. Fine wagon roads connect the more important towns, making transportation an easy matter during the greater part of the year. Batangas has long been known as one of the foremost agricultural districts of the islands. Considerable quantities of sugar cane and corn are annually grown, in addition to many minor products, such as coffee, abaca or Manila hemp, cacao, and garden produce.

CLIMATE.

Although Batangas Province is usually considered one of the southern provinces of Luzon, the climatic conditions correspond closely to those of the northern and western portions of the Island. No meteorological stations are located in the area under consideration, but a complete set of records has been kept at Punta Santiago in Batangas Province, distant about 30 kilometers from Batangas city. The rainfall records for this station are for the period beginning in 1886 and ending 1897.

¹ 483.9 square kilometers.

² 12.9 square kilometers.

³ \$1.04 per square kilometer.

Rainfall for Punta Santiago, Batangas Province.¹

	Millimeters.
January	6.5
February2
March	5.7
April	4.6
May	89.4
June	186.9
July	368.2
August	239.9
September	321.5
October	120.8
November	101.6
December	57.5
Total	1,517.5

These figures show a distinct wet and dry season, in common with other localities on the west coast of Luzon. During the period from June to October the rainfall amounts to 1,234 millimeters, more than four times as much during the period from November to May, when the rainfall only amounts to 283 millimeters. July, August, and September are the months of the greatest rainfall, while January, February, March, and April are the driest months, during which time the rainfall does not exceed 20 mm. Rainfall records taken at the city of Batangas would doubtless correspond closely to the figures given in the above table; but, in the upland country about Lipa, the rainfall is appreciably greater, while in the mountainous region in the southeastern part of the area, in the foothills of Malarayat range, as well as about Mount Macolod, showers are of almost daily occurrence, even during the months of least rainfall.

The temperature records for Batangas city are quite similar to those for Manila, and the records for the latter place are given in the following table:

	Monthly mean.
January	25.0
February	25.4
March	26.9
April	28.3
May	28.5
June	27.8
July	27.1
August	27.1
September	26.9
October	26.9
November	26.1
December	25.2
Annual mean	26.8

Comparing the table of monthly means with the figures given for the annual mean temperature, 26.8, it will be seen that there is little de-

¹ P. 212, Vol. IV, Philippine Commission Report.

parture from these figures. December, January, and February are the coldest months; April, May, and June the months of greatest heat. In the more elevated portions of the area the temperature is appreciably cooler, especially the night temperatures.

The monsoons blow with great regularity; the northeast monsoon from November to May, the southwest monsoon from June to October. The latter brings the moisture laden winds from the China Sea and causes the abundant rainfall of the wet season. In passing over the high ranges of mountains near the Pacific coast, the northeast monsoons lose their moisture content; consequently, they sweep across the province as dry, hot winds.

The unequal distribution of rainfall in the area is not the most favorable for the production of all classes of agricultural products; for frequently, as during the year 1902, the rainy season is light, and the long months of drought seriously affect the growth of such crops as sugar cane, corn, and tobacco. For the small garden crops irrigation is frequently practiced, but for the larger field crops this is hardly practicable, so that in such years of drought the entire crop is lost.

PHYSIOGRAPHY.

In discussing the prominent surface features of the area, for the sake of convenience they may be divided into three classes; coastal plains, upland plains, and mountains.

Coastal plains.—Bordering Batangas Bay from west of Bauang to the barrio Tabangao south of Batangas, varying in width from 1 to 2½ kilometers, is found a well-marked plain. This plain is a distinct physiographic unit and doubtless owes its origin to the gradual elevation that is taking place along the west coast of Luzon. On the landward side it comes in direct contact with the gradual sloping upland plains that comprise by far the greater portion of the area. The city of Bauang is located at the junction of the coastal plain with the upland plain, while Batangas lies very near the junction of the two plains. The coastal plain lies but a few meters above mean tide level. It is characterized by large areas of salt marsh land, where the natives engage largely in the manufacture of salt, and low lands with wet muck soils and small tidal streams and arms of the bay. Along the Calumpang River near Batangas, the alluvial plains of this river are extensive, and properly belong to the coastal plain. In this river the influence of the tides is felt to a short distance below Batangas. The small streams crossing this plain emerge from their deeply cut, narrow cañons and occupy wide stream courses but a few meters below the general level of the plain.

Upland plains.—Bordering the coastal plain and stretching northward and eastward for many kilometers come the broad plains that have been spoken of as upland plains. This physiographic feature comprises more than two-thirds of the entire area. Where it comes in contact with the

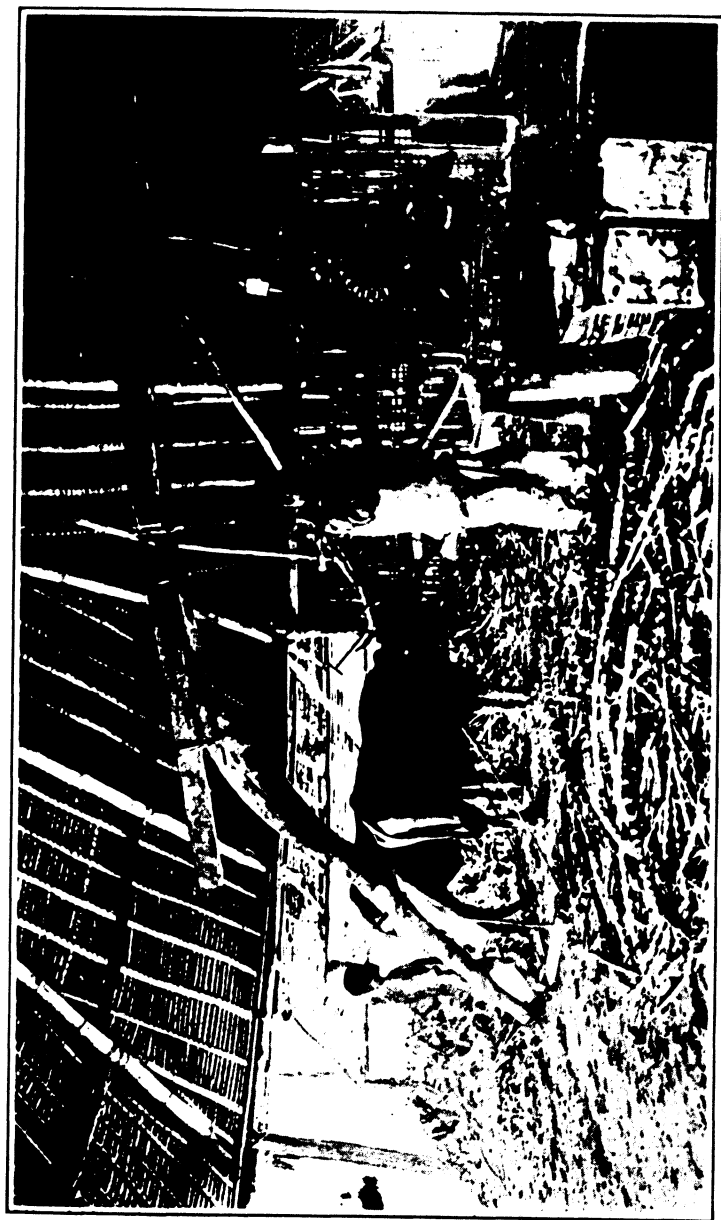


PLATE IX.—PRIMITIVE METHOD OF GRINDING SUGAR CANE, IN COMMON USE IN BATANGAS PROVINCE.

coastal plain, its elevation above sea level does not exceed 10 meters; but from this elevation it gradually rises northward to a few kilometers north of Lipa, where an elevation of more than 300 meters is attained. From here it begins to slope towards Laguna de Bay. Hence the drainage for the greater part of this plain is southward to Batangas Bay, and only a small portion of the rainfall drains into Laguna de Bay. This plain was formerly a continuous sloping plain, but stream erosion has considerably modified the surface. Remnants of the former continuous plain, unmodified by stream cutting, are observed in the broad level east of Taysan and New Rosario. Here for many kilometers but little change in elevation is noticed. Near the drainage divide about Mataas na Cahoy the rolling character is strongly pronounced. Along the tributaries of the Calumpang River south of Ibaan occur the most broken areas of this broad plain. Here the streams have deeply cut narrow gorges, from 50 to 100 meters below the general upland level, and the country consists of a succession of narrow winding ridges between the streams. Nearly all of the streams, a few kilometers from their source, rapidly cut narrow channels in the soft rocks, making road building costly and laborious. Many roads built during the Spanish regime cross these narrow cañons by means of handsome stone arches, which still remain intact, in spite of the numerous earthquakes that have occurred in the many years that have elapsed since their completion. From numerous points, owing to the open character of the country, the greater part of this plain can be seen. The entire portion of this plain is well drained, and only in the neighborhood of old Rosario is there any tendency to imperfect drainage conditions. Rising higher than the surrounding country are small, rounded hills that may properly be considered with the higher mountain ranges and peaks that will now be described.

Mountains.—Several prominent groups of mountains and many smaller isolated peaks stand out in bold relief, when contrasted with the rolling upland plains, and add scenic beauty to the area. The largest group of mountains is situated in the southeastern part of the area. This group contains many large peaks and smaller spurs and outlying hills. The group belongs to the region usually spoken of as the Lobo Mountains, and prominent peaks are Mount Biga, Mount Cabanag, Mount Pinagacutan, Mount Calumpit, Mount Sarumcastila, and others. The highest of these reach elevations of more than 700 meters above sea level. The turbulent streams in this region flow through cañons filled with huge boulders.

Mount Macolod, rising abruptly from the shores of Laguna de Bombon, forms one of the landmarks of the province. On clear days it can be seen from Manila Bay, and many other localities equally distant. A central peak, with prominent spurs leading from this, form the mountain. The town of Cuenca is located at the foot of one of the prominent spurs on the southern side of the mountain. The elevation of the cen-

tral peak probably exceeds 800 meters, while the total area does not exceed 10 square kilometers. The Malarayat range of mountains, lying to the east of Lipa a short distance, stand out in bold relief, but only the outlying foothills and spurs are situated within the limits of the area. The elevation of these foothills is only a few hundred meters above the country surrounding it.

In addition to these more important mountain peaks and ranges are the several smaller peaks that have been referred to. The largest of these is Mount Vigain, situated a short distance to the southeast of Cuenca. From its rounded contour and the flat character of the summit, it is undoubtedly a former volcanic cone. Mount Tumbol, at the foot of which the new town of Rosario is located, is a small rounded peak that rises from a level plain. It has long been considered an extinct volcanic peak. Other isolated peaks, somewhat similar to the ones just mentioned, are the peak near the barrio Añiláo south of Lipa and the prominent hill a short distance west of Ibaan.

GEOLOGY.

The geological features of the region may be briefly discussed under the same head as the physiographic features.

Coastal plains.—Composed of soft, unconsolidated silts and muds that have been recently deposited by the various streams that empty into Batangas Bay. Occasionally, in periods of great rainfall, the Calumpang River overflows its channel and contributes something toward the upbuilding of the littoral plain; but by far the greater part of the area consists of the sediments that have recently been deposited in shallow waters along the shore, and the gradual uplifting of this part of the island has formed the coastal plain into its present condition.

Upland plains.—Everywhere, underlying the soils of the upland plains but a short distance from the surface of the ground, are found distinctly stratified layers of soft grayish rocks, known as volcanic tuff. The same layers of this rock may be observed outcropping along the roads for distances of many kilometers. The layers vary somewhat in thickness and composition. By far the greater part of the material consists of a fine grayish silty material, partially solidified. From the continuity of the beds, it is evident that the material must have been deposited in quiet waters. In the deeper cuts, nearly 100 meters below the general upland level, many fine layers of nicely assorted black volcanic angular sand were observed. Along the Calumpang River, below Ibaan, advantage has been taken of the fine exposure of the soft gray rock, and many large quarries furnish building stone for the city of Batangas. While many of the beds are remarkably uniform in texture, some contain variously assorted material and leaves of plants are frequently found imbedded in the different rock strata. By far the greater part of this material has come from the Taal Volcano, situated on a small island in Laguna de Bombon, but a

short distance northwest of Mount Macolod. The rocks represent the finer ashes and detritus ejected from the volcano and deposited at a time when all of the great valley, from the Lingayen Gulf to Batangas Bay and Tayabas Gulf, was an open sea. The tuff is andesitic; that is, it belongs to the class of rocks known as andesites—rocks only moderately rich in silica. These tuffs decompose readily under the weathering influence of the atmosphere, and offer but little resistance to stream cutting as all—even the minor streams—flow through deeply cut channels.

Mountains.—In the mountainous areas, rocks somewhat similar to those just described, and many other classes of rocks, are also found. In Mount Macolod volcanic tuff is abundant, but it contains a larger percentage of larger and coarser material, and is more compact and harder than the tuff of the upland plains. In addition, hard reddish and black volcanic andesite rocks are found. The same rocks are also found in the southeastern part of the area, and the tuffs of this region may owe their origin to some one of the peaks of this chain of mountains, for Mount Loboo is frequently spoken of as a former volcanic crater. The same remarks apply to the rocks of the Mount Malarayat range, a peak of which, known as Susong-cambing, is supposed to be an extinct crater. In the smaller peaks and isolated mountains, two of which have been spoken of as former volcanic vents, only pyroclastic tuffs are found, although these are considerably harder and more resistant to weathering than the soft level strata underlying the upland plains. In the small mountain just south of the barrio Malabo, large outcrops of white crystalline limestone were seen. In former years this stone was burned to considerable extent, for lime and several abandoned lime kilns were noticed. Limestone occurs along the beach near Pinamucan and east of this barrio. These areas are probably far more recent than the first mentioned area of limestone near Malabo. Two of these areas give rise to distinctive black waxy clay soils that will be described.

SOILS.

Eleven types of soils of varying agricultural value and differing widely in their origin and method of formation were recognized and mapped. Of the alluvial soils, the Calumpang sandy loam and the Calumpang loam are the most valuable for general farming purposes. Of the residual soils derived in place by the slow decomposition of the underlying rocks, the Lipa loam possesses the greatest natural advantages, while the Talumpoc clay loam is the poorest of all the soils.

Ibaan clay loam.—This soil formation occupies by far the greatest area of any of the soils surveyed. About Ibaan this soil occurs typically developed; hence the name of Ibaan clay loam was chosen for the soil. The soil consists, to an average depth of 12 centimeters, of a reddish brown tenacious clay loam that is difficult to till and cultivate. In plowed fields the great masses of firmly baked clods plainly show the

stiff, unyielding character of the clay loam. These clods are in many cases almost as hard as the underlying rocks and can only be broken with the greatest difficulty. Little sand can be detected in the soils, although they frequently are granular, owing to the presence of firmly cemented particles of the rocks from which they are derived. Even on some of the more level areas, where considerable dpth of soil is to be expected, shallow plowing brings to the surface broken bits of the underlying rocks. The subsoil consists of heavy, stiff clay loam, of a more reddish color and, at an average depth of 30 centimeters from the surface, grades into partially decomposed underlying grayish and brownish rocks. In many cases the total depth of soil and subsoil does not exceed but a few centimeters, while in more favorable localities the depth of soil and subsoil attains a depth of 80 centimeters. Generally, however, the Ibaan clay loam is a shallow soil, that at the present time possesses little natural fertility. Plowed when wet, it forms large clods that soon bake and yield but little plant food to the growing crops unless, with great expenditure of labor, the soil is reduced to a fine state of tilth. This soil type occurs in a large unbroken area north of Batangas and Bauang, occupying large areas about San José and Ibaan. Away from the larger streams, the surface is generally level or gently rolling; but, near the junction of the principal streams, the country is greatly broken and not well adapted for farming purposes. The entire area slopes gradually northward and eastward, and has been elevated above sea level a sufficient length of time for the drainage to become well established. No undrained areas occur in the formation and, except in seasons of greatest rainfall, tile drains or open ditches are unnecessary.

From the uniform nature of the underlying strata of consolidated volcanic silts and muds sloping towards Batangas Bay, it is not remarkable that similar soil conditions should prevail over such wide areas. These rocks, uniform in character and composition, have weathered through the decomposing agencies of the atmosphere into the stiff, unyielding clay loams that comprise this formation. Undoubtedly, when the original forest growth was first removed, many centuries ago, the depth of soil was greater and more loamy and fertile in character, owing to the presence of humus and other vegetable remains, but the washing of the rains and imperfect cultivation have long since destroyed the humus and left them in their present impoverished condition.

Many crops are cultivated, the principal ones being sugar cane and corn. Many fields of the former crop were seen about Ibaan, while scattered patches of corn are found over the entire area. From the care and attention given cane crops, large yields can not be expected, and the primitive methods employed in extracting the juice and sugar-making would not seem to warrant the cultivation of this crop, with the present low prices of sugar in the world's markets.

The yields of corn are not large and, during seasons of extreme drought, do not justify the preparation of the land; moreover, the swarms of locusts which almost annually sweep over the province are a menace to the crop, which must be reckoned with.

Many small patches of tobacco are grown in different parts of the area, but only about San José does the crop assume any considerable proportions. The more loamy pieces of land near the houses are selected for the crop, which seldom exceed a hectare in extent. While some fields were seen that give promise of better results, with careful selection of seed and proper cultivation, the majority of the fields show plainly the lack of care and attention, for the leaves are badly torn and eaten by insects. Little attention is paid to topping and suckering; hence the tobacco grown is of inferior quality, and commands but low prices. It is frequently finely cut and sold in the markets at the rate of 7 cents gold per kilogram. It is principally used for a cheap grade of cigarettes.

Cacao (the variety known as Forastero) is grown extensively. Only a few trees are grown about each house, but the total product assumes considerable proportions. Along the road leading from Bauang to the barrio Balagbag the total number of trees amounts to thousands. The product is almost entirely consumed in the province.

Rice of the upland variety was formerly grown to a considerable extent; but at present, owing to the scarcity of carabaos, only limited quantities are grown. Much garden produce is grown also in small patches about the houses of the natives. In the sloping lands surrounding Laguna de Bombon, advantage is taken of the increased rainfall and greater humidity of the atmosphere, and abacá or Manila hemp is extensively grown. When these lands were visited (January, 1903), the entire region was suffering from protracted periods of drought, and the fields of abacá did not present a thriving appearance. The entire output from this region is utilized for the manufacture of native goods, so that considerable care is employed in extracting the fiber to get out only the finest and whitest products of the plant. On the same lands extensive plantings of cocoanut trees have been made, but no flattering results can be expected; for, on account of the distance from salt water and the uneven character of the surface, the lands are not adapted to cocoanut cultivation.

While formerly the greater part of the land of this soil formation was under a fair state of cultivation, the ravages of war were particularly severe, consequently, much land has been abandoned and thousands of hectares are now lying idle, growing up in coarse cogon grass. Along the ravines are found great clumps of bamboo, and the appearance of much of the country is desolate in the extreme. On the more exposed hills, where the soil is very shallow, the bush *Prosopis juliflora* grows in abundance and adds to the appearance of desolation.

Lipa loam.—The name Lipa is a Tagalo word used for a certain kind

of tree which it is supposed formerly grew in abundance about the present town of Lipa. The term Lipa loam was chosen for the large tracts of fertile loamy soils found about the town. The soil, to a depth of 25 centimeters, consists of a dark brown, rich looking loam that is mellow, easy to stir and cultivate, and gives evidence of lasting fertility. The subsoil is much darker in color, loamy in texture, but becoming more heavy and waxy at a depth of 75 centimeters from the surface. The total depth of soil and subsoil generally exceeds 1 meter. The broad, slightly rolling areas of this formation readily adapt it to extensive cultivation of large fields. Situated as it is, at a considerable elevation above sea level, the climate is cool and salubrious, and the rainfall greater than in the lower plains to the southward. The largest areas of the formation extend to the north of Lipa, but a small area occurs, bordering Laguna de Bombon to the west of Cuenca. The surface of the country is generally level, or only slightly rolling, for the drainage channels have not had sufficient time to carve deep gorges, as in so much of the country to the southward.

This soil is likewise residual and represents the decomposition products of the underlying volcanic tuffs. On account of the uniform character of the underlying strata of rocks and the generally level surface, the rocks are deeply weathered. So slight is the washing action of the heavy rains that even after a long period of cultivation the fields have not been deprived of their covering of loamy soils that give them their value for agricultural purposes. The Lipa loams comprise the best farming lands of the entire upland portion of the province. They are well adapted to the production of corn, coffee and sugar cane. Cotton would also prove a paying crop, for there is every reason to believe that, with proper cultivation, good yields of a fair grade of cotton can be grown. At present sugar cane is the principal crop, and large fields can be seen to the northeast of Lipa. Corn makes a good growth and is also one of the leading crops of this section of the province. The rich, loamy character of the soil makes it suitable for this crop, and good yields can be harvested. Tobacco, although nowhere in the province extensively cultivated, would be found a good money crop on this soil, with attention to the cultivation and selection of those varieties suited to the climatic conditions prevailing about Lipa. Cacao is grown only in limited quantities, and the climate is not especially adapted to a large extension of the industry. Rice is largely grown, but of the upland variety, and water is not available for irrigating extensive tracts of land. Some abacá is grown, but in small patches and only for use in the native looms for fabrics. Coffee was formerly one of the leading crops and contributed greatly to the wealth of the neighborhood, but fungus diseases and insects destroyed the old plantations, and little or no attempt has been made to revive the industry. Coffee of the hardy Liberian variety could, in the opinion of the writer, be profitably introduced, in spite of the pres-

ent low prices. In the old histories of the province, mention is made of the former cultivation of wheat, but it is to be doubted if any large plantings of this crop were practiced. Oranges and other fruits thrive well and find a ready sale in the local markets, as well as in Manila, to which they are exported in considerable quantities.

Prior to the insurrection, the area covered by this soil was one of the most flourishing agricultural districts in the whole Archipelago. The ravages of war were particularly severe but, in a short time, the district should be in a good condition—so favorable are the soil conditions for agricultural advancement and prosperity.

Taysan clay.—In the eastern part of the area, occupying many square kilometers, occurs a large body of land with uniformly similar soils, that has been named Taysan clay. Large typical areas of this soil are found about the towns of Taysan and Rosario, and stretching to the eastward far beyond the limits of the present survey. The surface soil, to an average depth of 16 centimeters, consists of a heavy black clay that is tough and tenacious, with a tendency to bake hard, forming great cracks in the surface. The subsoil usually consists of the same material, tough black clay, to an average depth of 35 centimeters from the surface. In places the subsoil is much lighter in color, but of the same character and texture and, from its impervious nature, does not allow the free passage of water through it. In some of the more level areas of this formation, the total depth of soil and subsoil exceeds one meter. Again, the underlying rocks may be found 20 centimeters from the surface. The surface of the country lies from 100 to 200 meters above sea level and, in general, is level or only gently rolling. To the north of Rosario, it gradually merges into the Lipa loams; to the south it likewise merges into the Talumpoc clay loam; while on the west the same gradation into the brown Ibaan clay loams is noticed. The line of contact with all of these soils is not sharply defined, but a gradual transition from the one type to the other. The continuity of the formation is broken by Mount Tumbol and the small mountain south of Lipa. It is only in the large area of Taysan clay east of the town of New Rosario that the drainage channels are not well established. The small streams wander about over the surface and, even in the protracted seasons of drought, there is a slight tendency to swampy conditions, so that in the rainy season large areas are covered with water that slowly drains away.

The origin of this type of soil is similar to that of the two preceding ones. It represents the decayed underlying strata of soft tuffs and scoriaceous sediments that have been deposited in water by the Taal Volcano, or some of the numerous volcanic vents that form so characteristic a feature of this portion of Luzon. The black color and almost mucky condition of the soils in some of the area is undoubtedly due to the poor drainage conditions and the decay of the rank growth of grass during long periods of years.

Coffee, even at the present time, is the principal crop and, although the plantations are poorly cared for, the product forms one of the leading money crops of the area. The large groves of decaying Madre Cacao trees tell of the former existence of extensive coffee fields.

For a long time the coffee industry was one of great importance to this district, for the product brought good prices in the Manila markets and compared favorably with the better grades of coffee grown in various parts of the world. Fungus and insect pests wrought great havoc to the bushes and, in a few years, the industry had dwindled to almost nothing. At present the few remaining groves are in a state of sad neglect, but crops are sold at a fair rate of profit in the local markets.

Some corn is grown on the drier, better drained soils. Sugar-cane while never extensively cultivated in this section, is also grown to some extent, but with only indifferent results.

In the eastern part of the area many fine bodies of land are seen that are admirably adapted to grazing purposes. The surface is thickly covered with a thick mat of rich succulent grama grass, that would furnish pasturage to large herds of cattle and horses. Little use is made of this land for this purpose, and large tracts of land are lying idle, not utilized for any purpose whatever. From the impervious nature of the subsoils, much of this open grazing country could be made the center of a large rice industry. The small streams would furnish an adequate water supply for considerable tracts of land at a nominal expense, while, for the further extension of such an industry, there is no doubt that an abundant supply of irrigating water could be reached by means of wells. As yet, there has been no attempt to get artesian wells but, from the nature of the underlying rock strata and the high range of mountains to the northward, a good supply of water should be reached at no inconsiderable depth.

Malabo waxy clay.—In the area surveyed are two small areas of soil that possess striking characteristics, that has been called Malabo waxy clay. As the name implies, the soil, to a depth of 45 centimeters, consists of rich, black, waxy clay. The percentage of clay is very high and this, with its peculiar waxy character, readily serves to distinguish this type of soil from the others just described. Little difference is observed between the soil and subsoil, except that the latter sometimes grades into a soft, yellowish clay, at considerable depth. Under the subsoil is found broken and partially decomposed limestone. The greater area of this soil is situated 15 kilometers directly east of Batangas, while the other area lies 7 kilometers southeast of the same city. The first area comprises the limits of a small mountain that lies southeast of the barrio Malabo. This small rounded mountain attains an elevation of 350 meters above sea level, and is symmetrical in outline. The smaller area is likewise situated in a rough, broken region, that forms the foothills of the

Loboo mountains. The elevation of this smaller area does not exceed 300 meters above sea level. Both areas, on account of the rolling mountainous character of the topography, are well drained, while their elevation insures a cooler climate and greater humidity and rainfall than in the lower plains.

Like the preceding soils, the Malabo waxy clay is residual, but has been derived from a totally different class of rocks. The rocks from which this soil has been derived are hard, crystalline limestones or marbles, composed largely of carbonate of lime and a slight amount of fine sediment. The rains tend to dissolve this easily-soluble rock, so that the soils consist principally of the fine sediment and impurities that composed the original rock. Soils derived in this manner from pure limestones are generally rich and fertile, and the soils of this formation certainly form no exception to the rule. The rank, luxurious growth of bushes and weeds at once denotes the great fertility of these soils. While difficult to plow and work, even with scant cultivation they yield good returns of the few crops cultivated. Only the lower slopes are cultivated, but good crops of corn are harvested, and all kinds of vegetables yield well, while bananas and other fruits make a wonderful growth. These soils are of lasting fertility and readily repay the extra cost necessary to thoroughly prepare them before planting. The limited extent of the areas occupied by this formation, and the lack of suitable transportation facilities, are the only obstacles in the way of making them important agricultural districts.

Macolod gravelly loam.—This formation occurs, typically developed, on Macolod mountain, as well as on some of the smaller peaks. The soil is similar in many respects to the Ibaan clay loam. It consists, to an average depth of 15 centimeters, of a brown, tenacious clay loam, that contains from 10 to 20 per cent of fine rounded gravel, about 5 millimeters in diameter. In some of the localities where this soil formation occurs, as on Mount Macolod, there is a slight admixture of sharp, angular gravel, composed of the hard, black volcanic rock known as andesite. On the upper slopes of the mountain, many bare rock surfaces are exposed, and the steep character of the slopes prevents any attempt at cultivation. On the foothills of the Malarayat range of mountains, soils of a similar nature are found: but on some of the slopes occur somewhat sandy loams, while on the higher, steeper slopes the soil covering is thin, and frequently wanting altogether.

These soils are all derived, by the process of slow decomposition, from the underlying rocks and, from the nature of the slopes, no great accumulation of soils can take place.

Cultivation of these soils is nowhere extensive. On the lower slopes of Mount Macolod some abacá is grown and, when a favorable site is chosen, fair results are obtained. On Malarayat mountain, the conditions seem better adapted to the growth of abacá and some fields of this crop, as

well as corn, coffee and tobacco fields, in a flourishing condition, were seen. On Mount Vigain, Tumbol and other isolated areas of this soil, no cultivation is practiced and, except for pasturing a few horses and cattle, no use is made of the land. On Macolod and Malarayat small patches of the original forest growth remain, but no attempt is made at the present to utilize the timber.

The shallow character of the soils and the steep slopes are against any considerable development of these lands. Some small areas occur where fields of abacá, corn and tobacco can be raised, but the greater part of the land is not well adapted to farming purposes.

Talumpoc clay loam.—In the southeastern part of the area occur large tracts of land with similar soils, called Talumpoc clay loam. The soil, to an average depth of 10 centimeters, consists of a hard, compact black clay loam. In places the depth of soil does not exceed 5 centimeters, while in others it is 18 or 20 centimeters in depth. The depth of soil depends largely on the character of the surface, although frequently, on the more level slopes, the covering of soil is quite shallow. Under the soil occur the hard, granular volcanic tuffs and other rocks from which the soils are derived. The area occupied by this formation is rough and mountainous, and the higher peaks attain an elevation of more than 700 meters above sea level. Sharp, angular and rounded peaks characterize the region, with deep, narrow valleys. The small streams are turbulent, flowing over beds filled with huge boulders. Earthquake shocks are numerous in the region, and one locality was observed where an area of more than one square kilometer had subsided, leaving great bare rock walls exposed many meters in height, while the ground was strewn with great angular boulders that bore evidence of the great convulsions of the earth that had taken place. This locality lies just west of the barrio Santo Niño, about 8 kilometers south of Batangas. On the higher, sharper peaks the soil covering is frequently wanting, and great boulders and rock walls are common.

The rocks which, through weathering, have formed the shallow soils, are all volcanic in origin, and consist of hard, compact granular tuffs and solid red and black andesites. The slow rate of decomposition of such rocks renders impossible any considerable accumulation of soil on the steep slopes.

The entire region is sparsely peopled, and the cultivation of the soil limited. Small crops of corn and garden produce are grown around the few houses, while the customary number of banana plants and orange and cacao trees are always seen. The greater part of the area is cleared, and showers of almost daily occurrence give the region a fresh, green appearance that is not seen in the lower plains during the dry seasons. Except for grazing purposes, for which the region is well adapted, on account of the cool, moist climate, the land has at present little agricultural value.

Calumpang loam.—In the low plains bordering Batangas Bay, and along the Calumpang River, are found many areas of varying size of Calumpang loam. The soil is a heavy, dark-colored loam, to a depth of 20 centimeters. Underlying this is found black, waxy, heavy loam that, at a depth of 60 centimeters, grades into stiff, sandy loam of a yellowish color. The soil is stiff and, with the present method of plowing, when the land is wet, bakes badly, forming great masses of large clods that can only be broken with considerable difficulty. The main areas of this type of soil are just east and south of Batangas; smaller areas are situated west of Batangas, while the city itself is located on this character of soil. The surface is quite level and forms wide terraces, situated but a few meters above sea level. The area is quite well drained, but the value of some few localities would be greatly enhanced by open or underground drainage. The origin of this soil is very different from the preceding ones. It represents the accumulations of fine sediment brought down by larger streams of the area and deposited in shallow water, in the manner in which large streams build up their flood plains. The level, terraced nature of much of the area undoubtedly proves that it has been formed by the slow accumulation of material during times of excessive rainfall. Soils that have been formed in this manner are, with few exceptions, fertile, and such is the case with this soil. It consists of the finer particles of soils carried long distances by the streams, and nearly always contains a good proportion of thoroughly decomposed vegetable remains that further increase the fertility of such soils. The principal crop on this soil, for many scores of years, has been sugar cane. The soil is well adapted to this crop and, prior to the insurrection, almost the entire area was cultivated in sugar cane. At present some large fields of this crop are seen, but much of the land is lying idle. The methods of grinding the cane and extracting the sugar are primitive in the extreme. No mills were seen that used steam power for grinding, while sugar-making is accomplished by the open kettle system methods in common use half a century ago. It necessarily follows that the manufactured product is of inferior quality, and can not command a high market price. Corn is grown on a small scale and, during years of protracted drought, the yield is slight; but in more favorable years a good return is made for the planter. Little or no rice is grown, but the nature of this soil adapts it nicely to this crop, and more profit could be made by growing this crop than by cultivating cane, with the present low prices. East of Batangas the manufacture of ollas or earthenware vessels provides employment for a large number of people. The waxy subsoil is dug up and kneaded to the proper consistency, when it is moulded by means of a wheel into the desired shape, and fired by surrounding the pile of freshly moulded jars and pots with dry pieces of bamboo. The entire work of preparing the earth, molding and firing,

is done within a period of a day. These pots and jars are carried on ponies in large baskets, or by the natives themselves, to all parts of the province.

Calumpang silt loam.—In the area surveyed are three small areas of Calumpang silt loam. The largest of these areas lies just west of Batangas, while the other areas are not more than two kilometers distant from the city—one southeast, the other northwest. The area of the three areas does not exceed one square kilometer. The soil, on account of the large proportion of silt it contains, bakes badly and forms firm clods that frequently have a glazed appearance. The soil differs from that of the Calumpang loam, in being more compact; consequently, it is more difficult to cultivate. The depth of grayish brown silt loam averages 20 centimeters. The subsoil is much more loamy in texture than that of the preceding soil. It possesses only to a slight extent the waxy character of the Calumpang loams. The subsoil is dark in color and much more easily drained than the subsoil of the Calumpang loam. On account of the more tenacious character of the soil, this soil type does not form as desirable a class of farming land as the Calumpang loam. The areas of this soil lie within the limits of the coastal plain. The surface is quite level, and elevated not more than 10 meters above mean tide level. The soil has been formed by the slow washing of the finer material into shallow waters, that have since subsided, leaving the deposit exposed. The area southeast of Batangas is, however, part of the flood plain built up by the small stream along which it occurs. This soil is also rich and fertile, and well adapted to the growth of sugar cane and corn; but more labor is necessary to prepare the land than the preceding soil type, but, with proper cultivation, the yields of both of these crops would be nearly as large. On the area just west of Batangas rice is grown, for which purpose, on account of the low position it occupies, it is well adapted. Zacate also forms a valuable crop on this area, by reason of the nearness to the city and the large demand for such feed, especially during the dry months.

Calumpang sandy loam.—Four areas of this soil type were found in the low country bordering Batangas Bay, the most important of which lies just south of Batangas, bordering on both sides of Calumpang River. The soil, to a depth of 25 centimeters, consists of a rich, mellow, sandy loam. Under this covering of brown, fertile soil occur fine sands and sandy loams, to a depth of more than one meter. This soil, on account of the percentage of sand it contains, forms for many purposes the most desirable soil of the entire province. Porous, well-drained, it can be cultivated when the more heavy soils are flooded with water; and, on the other hand, due to its situation and nearness to the Bay, it contains a good supply of moisture long after the heavier soils have become baked hard and dry.

The surface is level, in common with the other soils of the coastal plain.

The greater part of the area represents the present flood plain of the Calumpang River and, during periods of extreme high water, is liable to be overflowed. But such freshets do not occur oftener than once in every few years. The soil represents the coarser material brought down by the river in times of high water and deposited near the banks of the river.

The sandy, mellow character of these soils makes them especially adapted to the production of all kinds of garden vegetables, and some of the land is used for this purpose. The cultivation of radishes is carried on, on a large scale, and the abundant crops find a ready sale in the local markets. Sugar cane is largely grown and good crops are harvested, while corn does perhaps better than on any of the previously mentioned soils. On account of the nearness to Batangas, these lands command a high price and, for the production of the many crops adapted to such soils, they justly deserve it.

Muck.—Bordering Batangas Bay, or situated but a short distance from it, is a long, narrow area of muck. The surface of the land is very level and nowhere attains an elevation of more than 5 meters above sea level. The soil consists of black silt and clay, to a depth of more than one meter. The low position the area occupies accounts for the presence of standing water within a few centimeters from the surface, even during the dry season. In the rainy season the surface is generally covered with water. The saturated condition of these areas of muck renders the soil unfit for cultivation, except for certain special crops. The greater part of the land is diked and largely used for rice, which succeeds admirably on soils of this character. The cultivation of zacate is extensively carried on, and proves a paying crop, on account of the large demand in Batangas and Bauang. Several crops are annually harvested from the same field, and in the city of Batangas can be seen daily the vendors of fresh green grass cut from these fields. Some attempt is made to cultivate these fields, but the heavy, wet soils break into large masses that soon bake into hard clods that furnish scant nourishment to growing crops. During the dry season, when the surrounding country is burned and parched, the appearance of the fresh green zacate fields is specially pleasing.

Salt marsh.—Bordering the bay and extending in some cases as far inland as two kilometers, are three areas of salt marsh. These lands are low and flat and situated but a slight distance above tide level. Small tidal streams ramify through the areas and furnish the necessary salt water for the extensive operations in salt-making that are carried on. The land is laid off into a number of small farms, that are utilized for the manufacture of salt by the evaporation of sea water. Much of this land lies sufficiently high above the tidal streams to be utilized for cultivation, but salt-making has been carried on for many scores of years, and it is doubtful if other uses will be made of the land for many years to

come. The soil is generally sandy and, if washed free from the large amount of salt it contains, could be classed with the Calumpang sandy loams. The total area of salt marsh does not exceed 5 square kilometers.

AGRICULTURAL CONDITIONS.

Batangas Province was one of the first twenty political divisions into which the Island of Luzon was divided by the Spaniards, shortly after their arrival in the islands. Prior to this time, about the middle of the 16th century, it was known as the lands of Kumintang, on account of the sorrowful song which the natives generally sang. Situated close to Manila, it was early brought under the control of the Spaniards, and every inducement offered to agricultural advancement and prosperity, so that it soon gained an enviable position among the various provinces. As early as 1680, Lipa and Batangas were towns of several thousand inhabitants each. In the early histories mention is made of the cultivation of wheat, rice, coffee, indigo, corn, cotton, pepper, cacao, and all kinds of fruits and vegetables. Mention is also made of the abundant pasture lands and luxurious vegetation, while the soils are spoken of as being rich and fertile. From this early date, the position of the province was an important one, and it continued to increase in wealth and prominence until the last few years. The cultivation of sugar, and especially coffee, and the raising of fine cattle and horses, were the factors that gave distinction to the province. Mention has been made, in connection with the description of the Lipa loam and Taysan clay, of the destruction of the coffee industry. Before the destruction of the plantations by the insect belonging to the genus *Xylotrechus*, and the fungus of the genus *Hemileia*, large quantities of coffee were annually exported and, for quantity as well as quality, Batangas coffee ranked foremost among the coffee grown in the islands. The destruction of this industry was a severe blow to the province, while low prices for the last few years have destroyed the profits of sugar raising in the Philippines. The primitive methods employed in sugar-making and the lack of care in cultivating the growing cane, operate against getting large returns from the land, but formerly sugar cane was one of the principal crops. In nearly all of the area surveyed the remains of old sugar mills can be seen; but the present area under cultivation is restricted to those soils that are most favorable to this crop.

The province at the present time is in very poor condition; for, in addition to the decline of the sugar and coffee industries, the country was greatly devastated during the last insurrection. Thousands of native houses were burned, the crops destroyed, and cattle, horses and carabaos were killed in great numbers. The sites of former flourishing barrios are now marked by a thick tangle of weeds and underbrush, while occasional burned and blackened poles mark the location of the former houses. Thousands of hectares of land that, a few years ago, were under cultiva-

tion, are now covered by waving fields of coarse cogon grass and numerous ditches and trenches, half concealed by the long grass, tell of sharp fighting not many months since. One serious disadvantage in placing the province on its former footing is the lack of suitable beasts of burden, which suffered greatly during the last few months by the ravages of rinderpest. Batangas, in common with most of the provinces, lost many thousands of horses and carabaos. From this wholesale devastation of houses, fields and live stock, it will necessarily require considerable time to fully recuperate; but already the work of improvement has begun, fields are being cultivated, and houses are being constructed, while the provincial government is furnishing employment to large numbers of natives in building good roads to those towns not already so provided.

Most of the land is controlled by large owners, who lease it to the poor natives. In the more mountainous regions of the area much of the land is still owned by the government. About many of the towns the church owns fine tracts of farming land. Native labor is employed for cultivating the land, and the common price paid is two pesetas (\$0.15 U. S. currency) per day. The natives are all Tagalos, one of the original Malayan types of people that has been considerably modified by frequent crossing with other races, especially the Chinese. Farming is carried on in the most primitive manner. Plowing is accomplished by means of a rude plow drawn by a carabao, slow and sluggish in its movements, but strong and well suited to the conditions in many districts. The soil is seldom stirred below a depth of 12 centimeters, while the common practice of plowing where the soils are wet or under water tends to puddle them and form great masses of clods, which can not be thoroughly pulverized by the harrows in common use. Often these harrows are made by lashing a few pieces of bamboo together, while the projecting twigs serve as teeth to scratch the soil. Little or no fertilizers are used, even on the small patches adjoining the laborers' houses.

In addition to the sugar and coffee industries that have been mentioned, many other crops are cultivated that deserve mention. Corn is extensively grown in all parts of the area and, in favorable years, the yield is good. The ears are plucked from the stock and strung alongside the house, or on large frames which are specially constructed for drying and storing the crop. Cotton is grown as a perennial, and the plants are continually blossoming and the crop maturing. Small patches were noticed, but the crop is grown with indifferent results. On the more elevated lands, as about Lipa, there is every indication that cotton culture can be successfully carried on with good results. Proper care and cultivation are necessary to insure the success of the crop. Around the native houses are usually found a few cacao trees, which furnish a sufficient supply of chocolate for local consumption. The success attained by these trees would seem to favor a large extension of the industry, although the climate conditions are not so favorable to cacao in Batangas Province as

other parts of the Archipelago, where the rainfall is more equally distributed over the entire year.

Rice is largely grown at the present time, but the production does not equal that of a few years ago, when the cultivation of the crop was quite extensive. Except on certain areas, where water supply is available, rice will never be the leading crop in Batangas Province, as the surface features and elevation of the area better adapt it to crops other than rice. On the low lands adjoining Batangas Bay the area devoted to growing rice can be increased, while about Rosario the writer believes conditions favor the establishment of a large rice industry. Upland rice can be grown in many localities; but, as the quality does not compare with the lowland or irrigated rice, no great extension of upland rice cultivation can be expected.

The abundant areas of pasture land afford pasturage for live stock and, for a long time, Batangas ponies have brought good prices in Manila markets. Many fine cattle are to be seen in the province, that excel those of many other districts in the islands. Vegetables are grown to a considerable extent; on the road between Batangas and Bauang much care is taken and the soil thoroughly cultivated and irrigated, so that the quality of the garden produce probably excels that of other parts of the province. Oranges, bananas, mangoes and other fruits receive considerable attention, and yield a fair return to the planters. Tobacco raising should be encouraged, for many localities exist that will, with care and attention, produce a good quality of leaf, suited to cigars and cigarettes. On the level or rolling fields about Lipa, the loamy soils are excellent lands for many crops, and will bring good returns to the intelligent planter. They are especially adapted to corn, sugar cane, cotton, tobacco, fruits, coffee and vegetables. Almost every hectare of the Lipa loams which are found in this locality will, with proper attention, pay for its cultivation in any of the crops just mentioned. In the case of the Ibaan clay loams, occupying such large areas about Ibaan, San José and north of Bauang and Batangas, the case is different; the soils are more shallow, and of such a tenacious nature that cultivation is more difficult, and the returns less. On the level areas, where some depth of soil overlies the rocks, advancement can be made, and in such areas sugar cane, corn, and tobacco can be grown with profit; but thorough cultivation and fertilizers are necessary to build up much of the land depleted by scores of years of hard farming. The problems of the planter are more difficult and the returns correspondingly less on these soils than on the Lipa loam. About Rosario and Taysan the soil conditions of the Taysan clay are favorable to coffee culture and fruits and the cultivation of rice, and the pasturing of large herds of live stock.

Along the Calumpang River, near Batangas, the areas of loam and sandy loam soils are favorable to growing sugar cane and corn; these soils

are rich and, in spite of the high price of the land, will bring fair profits to the careful planter. The problem of the mountainous soils is difficult; the soils are generally thin and poor, and not well adapted to cultivated crops. Many fine stretches of land can be found, however, that are evidently suited to grazing purposes.

Batangas Province stands well at the head of the list, for the many fine roads it contains, that are in good condition, even during the height of the rainy season. A fine military road leads from the Playa near Batangas, through San José and Lipa to Calamba. This road is at all times in good condition, and furnishes means of communication from the central portion of the province to water transportation on Laguna de Bay or Batangas Bay, where daily boats leave for Manila or other ports. From Batangas, also, a fine road leads to Bawang, and on to Taal. Many roads in fair condition during the greater part of the year connect many of the pueblos and barrios. Generally speaking, the roads of the province are numerous and in good condition during many months of the year. Batangas and Bauang are both situated near the Bay of Batangas and, at the former place, frequent boats to Manila and other points in the islands afford cheap transportation for those products that are exported from the province. The only water transportation in the interior of the province is the Calumpang River. Large rafts are constructed of bamboo, and hauled up and down the river by carabao for a distance of many kilometers above Batangas. Little use is made of Laguna de Bombón for transportation purposes, although a recent rumor states that the river leading from it to Balayang Bay will be deepened, making it navigable for small steamboats and lorchas. This will enable products from much of the northern part of the province to be shipped more cheaply to Manila than formerly.

Batangas and Lipa, as well as the smaller towns, maintain large markets that provide a ready sale of much of the minor produce of the province, while the nearness to Manila and cheap transportation are advantages of some consequence.

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